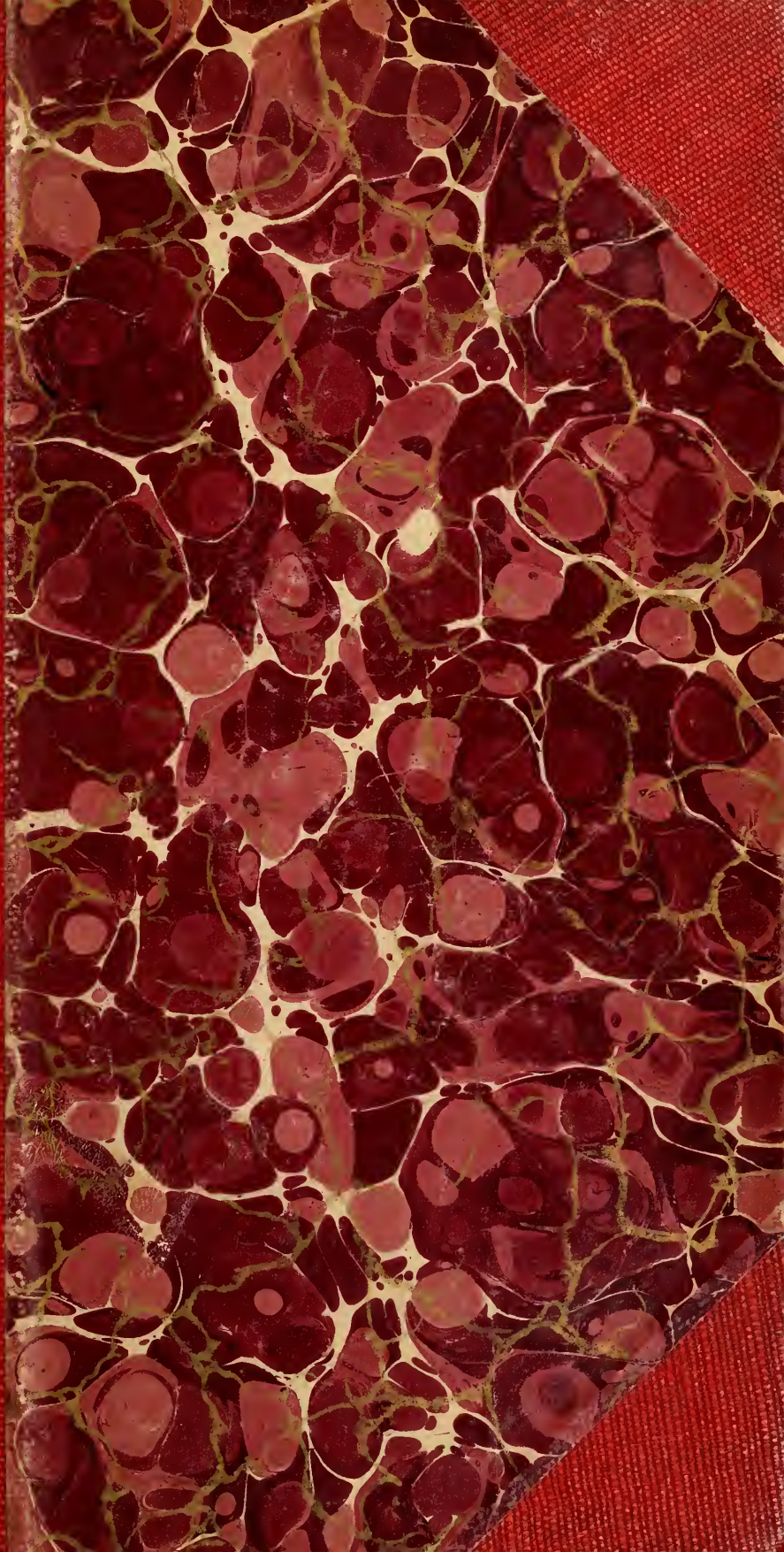

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TRANSACTIONS

OF THE

KANSAS ACADEMY OF SCIENCE.

VOLUME XXII.

CONTAINS

LIST OF OFFICERS AND PAST PRESIDENTS; MEMBERSHIP LIST JANUARY 1, 1909; MINUTES OF FORTY-FIRST ANNUAL MEETING; PRESIDENT'S ADDRESS; MEMORIAL TRIBUTES TO PROFESSOR SNOW, AND SOME PAPERS READ.

December 31, 1908,
January 1, 2, 1909.

STATE PRINTING OFFICE,
TOPEKA, 1909.
4220

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OFFICERS OF THE ACADEMY, 1909.

President.....F. B. DAINS.....Topeka.
Vice-president.....J. M. MCWHARF.....Ottawa.
Vice-president.....ALVA J. SMITH.....Emporia.
Treasurer.....F. W. BUSHONG.....Lawrence.
Secretary.....J. T. LOVEWELL.....Topeka.

Past Presidents of the Academy.

1869, '70..... B. F. Mudge.
1871–'73..... John Fraser.
1874–'78..... F. H. Snow.
1879, '80..... B. F. Mudge.
1881, '82..... J. T. Lovewell.
1883..... A. H. Thompson.
1884, '85..... R. J. Brown.
1886..... E. L. Nichols.
1887..... J. D. Parker.
1888..... J. R. Mead.
1899..... T. H. Dinsmore, jr.
1890..... G. H. Failyer.
1891..... Robert Hay.
1892..... E. A. Popenoe.
1893..... E. H. S. Bailey.
1894..... .... L. E. Sayre.
1895..... Warren Knaus.
1896..... D. S. Kelly.
1897..... S. W. Williston.
1898..... D. E. Lantz.
1899..... E. B. Knerr.
1900..... A. S. Hitchcock.
1901..... E. Miller.
1902..... J. T. Willard.
1903..... J. C. Cooper.
1904..... Edward Bartow.
1905..... L. C. Wooster.
1906..... F. O. Marvin.
1907..... J. A. Yates.
1908..... E. Haworth.

MEMBERSHIP OF THE ACADEMY.

January 1, 1909.

Dates in the following list signify date of election to membership in the Academy.

HONORARY MEMBERS.

G. P. Grimsley, Ph. D., 1904, asst. state geologist, Morgantown, W. Va.
Rev. Johns D. Parker, Ph. D., 1897, New Haven, Conn.
Edw. L. Nichols, Ph. D., 1897, Cornell Univ., Ithaca, N. Y.
W. S. Franklin, Sc. D., 1897, Lehigh Univ., South Bethlehem, Pa.
Geo. Wagner, Phar. D., 1904, Univ. of Wisconsin, Madison, Wis.
S. W. Williston, Ph. D., 1902, Univ. of Chicago, Chicago, Ill.

ASSOCIATE MEMBERS.

Mrs. R. J. Brown, 1903, Leavenworth.
Mrs. Mary Savage, 1897, Lawrence.

LIFE MEMBERS.

E. H. S. Bailey, Ph. D., 1883, Univ. of Kansas, Lawrence.
J. C. Cooper, 1877, mineralogist, Topeka.
F. W. Cragin, Ph. D , 1880, Colorado Springs.
L. L. Dyche, M. S., 1881, Univ. of Kansas, Lawrence.
Geo. H. Failyer, Ph. D., 1879, Dept. of Agr., Washington, D. C.
E. C. Franklin, Ph. D., 1884, Stanford Univ., Stanford, Cal.
I. D. Graham, 1879, with *Kansas Farmer*, Topeka.
Erasmus Haworth, Ph. D., 1882, Univ. of Kansas, Lawrence.
Warren Knaus, M. S., 1884, editor, McPherson.
D. E. Lantz, M. S., 1887, Biological Surv., Washington, D. C.
J. T. Lovewell, Ph. D., 1878, chemist, Topeka.
F. O. Marvin, C. E., 1884, Univ. of Kansas, Lawrence.
J. R. Mead, 1879, Wichita.
Ephraim Miller, Ph. D., 1873, Univ. of Kansas, Lawrence.
E. A. Popenoe, A. M., 1872, Kansas Agr. Coll., Manhattan.
L. E. Sayre, Ph. M., 1885, Univ. of Kansas, Lawrence.
Alva J. Smith, 1893, county surveyor, Emporia.
B. B. Smyth, 1880, curator Goss ornith. coll., Topeka.
C. H. Sternberg, 1896, explorer and collector, Lawrence.
A. H. Thompson, D. D. S., 1873, Topeka.
M. L. Ward, D. D., 1880, Ottawa Univ., Ottawa.
J. T. Willard, M. S., 1883, Kansas Agr. Coll., Manhattan.
S. W. Williston, Ph. D., 1880, Univ. of Chicago, Chicago, Ill.

ANNUAL MEMBERS.

Frank G. Agrelius, A. M., 1905, Univ. of Kansas, Lawrence.
Wm. Aitkenhead, B. S., 1906, Washburn Coll., Topeka.
H. C. Allen, 1904, Univ. of Kansas, Lawrence.
John J. Arthur, 1904, Topeka.
W. M. Bailey, 1906, teacher, Holton.

ANNUAL MEMBERS.

B. P. Baker, 1909, Topeka.
Elam Bartholemew, M. S., 1905, mycologist, Stockton.
Edward Bartow, Ph. D., 1897, state water survey, Urbana, Ill.
Frank G. Bedell, 1904, Iola.
J. W. Beede, Ph. D., 1894, Univ. of Indiana, Bloomington, Ind.
F. H. Billings, Ph. D., 1909, Univ. of Kansas, Lawrence.
Julius Brandt, 1907, Bethany College, Lindsborg.
H. H. Braucher, 1907, teacher, Emporia.
E. W. Brown, B. S., 1909, Fort Scott high school, Fort Scott.
Edw. Bumgardner, M. D., 1896, Univ. of Kansas, Lawrence.
L. D. Bushnell, 1909, Agricultural Coll., Manhattan.
F. W. Bushong, D. S., 1896, Univ. of Kansas, Lawrence.
H. P. Cady, M. D., 1904, Univ. of Kansas, Lawrence.
I. D. Cardiff, Ph. D., 1909, Washburn Coll., Topeka.
F. P. Clark, M. D., 1909, University Hospital, Kansas City, Kan.
W. A. Cook, M. S., 1907, Clay county high school, Clay Center.
Rev. John T. Copley, 1903, Clinton.
E. G. Corwine, 1905, Mulvane.
F. F. Crevecœur, 1899, entomologist, Onaga.
S. J. Crumbine, M. D., 1909, secretary State Board of Health, Topeka.
B. J. Dalton, B. C. E., 1909, Univ. of Kansas, Lawrence.
F. B. Dains, Ph. D., 1902, Washburn Coll., Topeka.
Emil O. Deere, A. M., 1905, Bethany College, Lindsborg.
James Dickson, A. M., 1904, Univ. of Kansas, Lawrence.
Robt. K. Duncan, 1906, Univ. of Kansas, Lawrence.
R. B. Dunlevy, B. S., 1896, S. W. Kansas Coll., Winfield.
E. H. Dunmire, B. S., 1905, Univ. of Kansas, Lawrence.
C. W. Edmondson, Ph. D., 1909, Washburn Coll., Topeka.
H. W. Emerson, B. S., 1904, Univ. of Kansas, Lawrence
B. F. Eyer, B. E., 1894, Agricultural Coll., Manhattan.
T. L. Eyerly, 1906, high school, Dallas, Texas.
Fred Faragher, A. B., 1904, Univ. of Kansas, Lawrence.
A. O. Garrett, 1901, teacher high school, Salt Lake City, Utah.
Frank Gephart, M. D., 1906, N. W. Univ. Med. Dept., Chicago, Ill.
R. W. Gragg, 1907, Bartlesville, Okla.
O. S. Groner, 1907, Ottawa Univ., Ottawa.
H. J. Harnly, B. S., 1903, McPherson Coll., McPherson.
W. A. Harshbarger, B. S., 1900, Washburn Coll., Topeka.
Frank Hartman, 1905, high school, Wichita.
L. D. Havenhill, B. S., Univ. of Kansas, Lawrence.
T. J. Headlee, Ph. D., 1907, Agricultural Coll., Manhattan.
W. C. Hoad, B. S., 1904, Univ. of Kansas, Lawrence.
W. F. Hoyt, A. M., 1902, president of Kansas Wesleyan Coll., Salina.
Albert K. Hubbard, Ph. B., 1904, Univ. of Kansas, Lawrence.
Thomas M. Iden, 1897, State Normal School, Emporia.
H. L. Jackson, B. S., 1909, Univ. of Kansas, Lawrence.
John J. Jewett, 1902, San Bernardino, Cal.
F. E. Jones, 1909, manual training school, Lawrence.
W. H. Keller, 1898, high school, Effingham.

ANNUAL MEMBERS.

Pierce Larkin, 1902, Helena, Okla.
Leslie A. Kenoyer, 1906, Independence.
Harry L. Kent, 1904, State Normal School, Hays.
John H. Klopfer, 1904, collector, Topeka.
R. D. Landrum, B. S., 1909, Univ. of Kansas, Lawrence.
M. A. Low, 1906, attorney C. R. I. & P. railway, Topeka.
L. A. Lowther, 1907, superintendent of schools, Emporia.
F. A. Marlatt, B. S., 1907, machinist, Agricultural Coll., Manhattan.
R. Matthews, D. D. S., 1898, Wichita.
D. F. McFarland, Ph. D., 1903, Yale University, New Haven, Conn.
W. P. McCartney, 1909, chemist, Topeka.
J. M. McWharf, M. D., 1902, Ottawa.
Grace R. Meeker, 1899, Ottawa.
J. M. Meade, C. E., 1909, Topeka.
C. F. Menninger, M. D., Topeka.
W. L. Moodie, 1906, Univ. of Kansas, Lawrence.
Roy L. Moodie, Ph. D., 1909, Univ. of Kansas, Lawrence.
C. A. Nash, 1907, teacher, Emporia.
J. H. Newby, 1899, photographer, Osage City.
N. P. Nielsen, 1906, architect, Topeka.
A. M. Nissen, A. M., high school, Wetmore.
H. N. Olson, 1905, Bethany College, Lindsborg.
J. B. Parker, 1909, Agricultural Coll., Manhattan.
Frank Patrick, 1903, Kansas City, Mo.
Leslie F. Paull, B. S., 1903, Agricultural Coll., Ft. Collins, Colo.
L. M. Peace, A. B., 1904, Univ. of Kansas, Lawrence.
Arthur D. Pitcher, A. M., 1906, Univ. of Kansas, Lawrence.
Norman Plass, D. D., 1902, Boston, Mass.
M. A. Pond, 1906, Topeka.
L. M. Powell, M. D., 1906, Topeka.
C. S. Prosser, M. S., 1892, Ohio State Univ., Columbus, O.
W. S. Prout, 1904, Topeka.
Albert B. Reagan, 1904, Indian school, La Push, Wash.
H. A. Rice, C. E., 1909, Univ. of Kansas, Lawrence.
B. R. Rogers, D. V., 1907, Agricultural Coll., Manhattan.
F. K. Sanders, D. D., Ph. D., 1909, Washburn Coll., Topeka.
D. C. Schaffner, 1903, College of Emporia, Emporia.
J. H. Schaffner, A. M., M. S., 1902, Univ. of Ohio, Columbus, O.
Theo. H. Scheffer, M. S., 1903, Agricultural Coll., Manhattan.
Miriam Sheldon, A. M., 1906, Univ. of Kansas, Lawrence.
E. T. Shelly, M. D., 1902, Atchison.
Claude J. Shirk, 1905, McPherson College, McPherson.
J. A. G. Shirk, 1904, Ottawa University, Ottawa.
Ralph C. Shuey, 1905, Univ. of Kansas, Lawrence.
Eugene G. Smyth, 1901, Bureau of Ent., Washington, D. C.
Mrs. L. C. R. Smyth, M. S., Ph. D., 1902, Topeka.
Wesley U. Speckman, 1903, Wesleyan University, Salina.
S. G. Stewart, M. D., 1904, Topeka.
Chas. M. Sterling, A. B., 1904, Univ. of Kansas, Lawrence.

ANNUAL MEMBERS.

E. F. Stimpson, 1904, Univ. of Kansas, Lawrence.
Edgar Thomas, 1907, State Normal, Emporia.
F. J. Titt, B. S., 1898, Kingfisher College, Kingfisher, Okla.
J. E. Todd, A. M., 1907, Univ. of Kansas, Lawrence.
David Train, 1907, student, Lindsborg.
J. F. True, 1909, stockman, Topeka.
E. S. Tucker, 1904, assistant, Department of Agriculture, Dallas, Tex.
W. A. Van Voris, 1907, State Normal, Emporia.
P. F. Walker, 1905, Univ. of Kansas, Lawrence.
J. D. Walters, M. S., 1894, Agricultural College, Manhattan.
J. E. Welin, 1899, Bethany College, Lindsborg.
Archie J. Weith, 1906, Univ. of Kansas, Lawrence.
W. B. Wilson, 1903, Ottawa University, Ottawa.
C. H. Withington, B. S., 1903, Univ. of Kansas, Lawrence.
H. I. Woods, M. S., 1902, Washburn College, Topeka.
L. C. Wooster, Ph. D., 1897, State Normal School, Emporia.
J. A. Yates, M. S., 1897, Manual Training School, Pittsburg.
C. M. Young, A. M., 1909, Univ. of Kansas, Lawrence.
Total number of members January 1, 1909, 153.

MINUTES.

Forty-first Annual Meeting, Kansas Academy of Science,

December 31, 1908, January 1, 2, 1909, at Topeka, Kan.

ABOUT fifty members met in the supreme court room in the state-house at 7:30 P. M., and were called to order by the president, E. Haworth. The secretary being called on for his report, referred to the minutes of the last meeting, already published in the Transactions (volume XXI, pt. 1), making the reading here unnecessary, and continuing, reported as follows:

We are getting used to our new quarters, and perceive certain advantages which they have over our old rooms in the basement. It is not pleasant to remember the uncertain tenure of our present rooms, since this edifice was not constructed primarily to make a home for the Academy, and any quarters assigned to us now must be regarded as a makeshift, and the Academy awaits permanent quarters in a new building, to be erected, as we hope, in the not distant future. The state officials thus far have given very respectful recognition to our claims, and the best has been done which the conditions permitted.

The annual publication of our Transactions is a great advance over the old plan of making it an appendix to the biennial report of the State Board of Agriculture. The Academy should represent the scientific enterprise and progress of the state, and should include in its membership a much larger number of those who are able to contribute to this end. In a year like this there is need of a legislative committee, who will keep duly informed of the measures before our legislature, and be prepared to advance the interests of the Academy in all proper ways. If we do not go forward we must retrograde, and that is a thing not to be allowed in Kansas. The papers submitted in our program this year will certainly give us a very valuable volume of Transactions, and the discussions should prove interesting and stimulating.

A part of the program herewith gives a list of the papers, numbered so as to make reference convenient.

CHEMICAL AND PHYSICAL PAPERS.

1. Resins in Vanilla Extract, H. L. Jackson.
2. An Examination of Apparatus for a Simple Determination of Carbon Dioxid in Air, E. H. S. Bailey and C. A. Nash.
3. Sulfites as Preservatives, Edith A. Goodwin and E. H. S. Bailey.
4. The Character of the Mid-continent Petroleum, F. W. Bushong.
5. Fluctuations in the Mineral Contents of the Kaw River, F. W. Bushong and A. J. Weith.
6. The Importance of Pharmacological Methods in Drug Assay, Adolph Ziefle.
7. Suggested Legislation in Regard to the Selling of Cocaine, H. W. Emerson.
8. Enameling Steel, R. D. Landrum.
9. The Relation of Manganese to the Corrosion of Iron, H. P. Cady.
10. Progress of Work in Drug Analysis Under Pure Food and Drugs Law, L. E. Sayre.
11. Comments on Analysis of Spices, L. E. Sayre.
12. Study of the Cause of Coal-mine Explosions, C. M. Young.
13. The Medullary Ray as an Element of Strength in Structural Timber, F. E. Jones.
14. On Some Methylene Derivatives, F. B. Dains.
15. Recent Investigations of the Properties of Steam, P. F. Walker.
16. Pelton Water-wheel Test Made at the University of Wisconsin in the Summer of 1908, Chas. I. Corp.
17. Some Notes on the Steel-hardening Minerals, J. C. Cooper.
18. A Speculation in Crystallography, J. E. Todd.
19. Economy of Heat in Cooking, J. T. Lovewell.
20. Some Difficulties in Testing Food for Sulfites, J. T. Willard and C. A. A. Utt.

GEOLOGICAL PAPERS.

21. Some Notes on the Olympic Peninsula, Washington, A. B. Reagan.
22. The Formations of the Marion Stage of the Permain, J. W. Beede.
23. Why the Southern Hemisphere is the Principal Water Hemisphere and the Northern the Principal Land Hemisphere, J. J. Jewett.
24. The Drainage of the Kansas Ice-sheet, J. E. Todd.
25. Expedition to the Laramie Beds of Converse County, Wyoming, 1908, C. H. Sternberg.
26. A Study of Certain Features of the Lawrence Shales, J. A. Yates.
27. The Extremities and Skull Structure of Diplocaulus, with Restoration, S. W. Williston.
29. The Skull Structure of *Diplocaulus magnicornis* Cope, R. L. Moodie.
30. Carboniferous Quadrupeds of Kansas, R. L. Moodie.

BIOLOGICAL PAPERS.

31. Care of Mammal Skins for Museum Specimens, L. L. Dyche.
32. A New Bird for the Kansas List, taken at Lawrence, L. L. Dyche.
33. Supplementary Additions to the List of Kansas Diptera, E. S. Tucker.
34. Weismann's Germ Plasm Hypothesis Untenable, L. C. Wooster.
35. Notes on a Captive Heloderma, B. B. Smyth.
36. The Birds of the Olympic Peninsula, Washington, A. B. Reagan.
37. Trees and Shrubs of Kansas, B. B. Smyth.

38. Distribution, Natural Enemies and Breeding Habits of the Kansas Pocket Gophers, T. H. Scheffer.
39. The Poison-glands of a Rattlesnake during the Period of Hibernation, L. L. Dyche.
40. Notes on Bats, Lumina C. R. Smyth.
41. The Latest Tests for Gas-forming Bacteria in Water, W. B. Wilson.
42. Additions to the List of Kansas Coleoptera, W. Knaus.
43. Some Notes on Kansas Coleoptera, W. Knaus.
44. Note on the Northern Distribution of *Amblychila cylindriformis* Say, W. Knaus.
45. Kansas Coleoptera of the Families Colydiidæ, Cucujidæ, Cryptophagidæ, Mycetophagidæ, Dermestidæ, Histeridæ, Nitidulidæ, Lathridiidæ, Trogositidæ, Parnidæ, Heteroceridæ, Dascyllidæ, and Rhipiceridæ, W. Knaus.
46. Intercellular Spaces in Plants, L. A. Kenoyer.
47. Some Notes on the Common Mole, T. H. Scheffer.
48. Coccidæ of Kansas, G. A. Dean.
49. Notes on Kansas Mammals, D. E. Lantz.
50. Some Interrelations of Protozoa, C. H. Edmondson.
51. List of Insect Types and Co-types in the Collection of the University of Kansas, C. H. Withington.
52. Habits of Parasitic Hymenoptera, II, C. H. Withington.

MISCELLANEOUS PAPERS.

53. The Importance of Having Standard Weights and Measures, E. F. Stimpson.
54. Temporary Industrial Fellowships, R. E. Duncan.
55. Railway Rates from an Engineering Standpoint, B. F. Dalton.
56. The Centenary of Charles Darwin, A. H. Thompson.
57. Estimation of the Relative Value of Feeds. E. B. Cowgill.
58. Further Notes on the Influence of Heredity in Stock-breeding, I. D. Graham.
59. Ups and Downs of our Homes from an Architect's Point of View, N. P. Nielsen.
60. Some Glimpses of Tahiti, C. H. Edmondson.
61. Cancer, J. M. McWharf.
62. The Cause and Prevention of Tuberculosis. S. C. Emley.
63. An Improved Water-supply for the City of Emporia. A. J. Smith.
64. Indian Remains in the Canadian River Valley, T. L. Eyerly.
65. Notes on Photography of Wild Birds, J. B. Parker.
66. A New Geometrical Figure and its Possible Application, E. C. Warfel.
67. Preliminary Note on Measuring the Speed of Photographic Shutters, H. I. Woods.
68. Views and Notes from Utah, I. D. Cardiff.
69. An Armored Dinosaur from Kansas Shale, C. H. Sternberg.
70. Preliminary Report of an Investigation of Coal-mine Explosions, E. Haworth and C. M. Young.
71. Harmonic Forms, B. B. Smyth.

LIBRARY.

Since the last report the library has had a steady growth. Few purchases have been made, but about fifty bound volumes of government publications have been received and placed on our shelves. Many of these are quartos, and nearly all are large-sized volumes, well printed, and of much intrinsic value.

Most of our accessions come to us as unbound pamphlets from other scientific bodies in exchange for our own Transactions. These bulletins are filed away till volumes are completed and ready to be sent to the bindery. During the past year over 500 volumes have been placed in the hands of the state printer and will soon be nicely bound.

We need more shelf-room for our books, and among the things to be asked for by us from this legislature is an appropriation for bookcases sufficient for 2500 volumes. Our Transactions are the capital which we use in building up our library, and these have been hitherto stored in one of the small committee rooms, but in preparing for the legislature our books had to be moved out into the corridor, where they now lie, with no protection from depredation.

We still need an index catalogue of our books, and to prepare this much time, labor and expert knowledge are required. The most that can be done by your secretary, without clerical help, is to arrange the books in sets according to language and place of publication, and place them on the shelves with some approximation to order and utility.

It has been proposed to have a State Library Commission, which shall have charge of all the state-house collections of books, and then have a general and complete catalogue made according to the best modern system. This would enable the users of books to find whether the information sought is to be found in the state-house, and, if so, where to get it. The state library cataloguers have been at work for some years on a Dewey catalogue, and the State Historical Society has made some progress in cataloguing its very large collection of books. The great fault now is that these libraries do not work together. There is much needless duplication of books, especially of government publications, and there can be no general classification of books into departments. A library commission with a competent head librarian could rectify all these faults and greatly increase the value of the state-house books which is the largest collection in our state. When this is done, and when the state provides a suitable building for its libraries and museums,

our Academy must be prepared to take a proper share in the work of administering these institutions.

MUSEUM.

The founders of our Academy—men like Snow, Mudge, Parker, Carruth, and Savage—were interested in geology, botany, and natural history, and delighted to bring specimens to the Academy, where they were stored for many years in the old quarters of the secretary of the State Board of Agriculture. The wonderful Kansas exhibit organized by Secretary Gray for the Centennial was brought back to the museum accretions, and it also was stored in the crowded agricultural rooms till the time of the St. Louis Exposition, when another display was made, showing especially the mineral resources of Kansas. Secretary Grimsley, who had charge of this exhibit, secured its donation to the Academy at the close of the St. Louis Exposition. This is to-day the foundation of our museum. Its transference to the north corridor of the fourth floor of the state-house was unfortunate in putting it where there is lack of light, which might be remedied by suitable power in the lighting plant of the state-house. There is no display in the capitol so useful as this might be if properly developed.

The secretary's report was adopted, and the treasurer, being called on, reported as follows:

	Receipts.	*Expenditures.*
Balance on hand from last year	$297 38	.....
Received fees and dues	105 00	.....
Received interest on time deposit	6 00	.....
Total	$408 38	.....

Of the assets, $350 is on time deposit at three per cent. in the Emporia National Bank, and the remainder is on sight deposit in the same bank.

ALVA J. SMITH, *Treasurer.*

This report was audited by W. H. Keller, and adopted.

The President next named the following committees:

On nominations: Sayre, Willard, and Thompson.

On resolutions: Knaus, Wooster, and Bailey.

On program: Bushong, Dains, and Kenoyer.

On necrology: Miller, Willard, and Harshbarger.

On time and place: Yates, McWharf, and Parker.

On audit: Keller and Dyche.

On membership: Cady, Scheffer, and Edmondson.

On publication: Haworth, Dains, and Lovewell.

On press: Sayre and Knaus.

On legislation: Lovewell, Dains, Sayre, Willard, and Yates.

After naming the committees, the president introduced Prof. E.

Miller, who read an address commemorative of his late colleague, Dr. Francis Huntington Snow.

The address was followed by a paper read by Professor Dyche, who spoke of Professor Snow as a collector, and of his collections. Professors Sayre and Stevens followed, speaking of Doctor Snow as a teacher. Professor Marvin gave an account of Doctor Snow's scientific papers. Doctor Thompson and Professor Smyth gave personal reminiscences of Doctor Snow, and there were letters from Professor Beede and others, bearing tributes to his memory. In another part of this volume these memorial papers are fully set forth.

The Academy then adjourned to meet in the supreme court room to-morrow, at nine A. M.

FRIDAY, January 1, 1909.

Pursuant to adjournment, the Academy met and was called to order, and minutes of previous meeting were read and approved.

Discussion ensued relating to purchase of books, and it was voted to have a library committee to consider the matter. Lovewell, Dains and Sayre were so named, and later reported as follows:

It is the opinion of this committee that further appropriations for books should be postponed until provision shall have been made to properly care for them and make them utilizable to the members of the Academy. It is recommended that the appropriation of money already made be not expended until this provision for storing and utilization be made.

It is the opinion of the committee that a start be made toward collecting books relating to the biography and bibliography of science; and to obtain scientific works not likely to be accessible in other libraries. It is recommended that this committee be continued, and that it be given prescribed power, acting with the officers of the Academy, by which the above provision can be carried out. Volumes to be purchased must be recommended by this committee and voted upon by the Academy.

This report was adopted by the Academy. The next order was the reading of papers.

Professor Sternberg reported his discovery of an armored dynosaur in the Kansas chalk.

Professor Sayre commented on the analysis of spices. Discussed by Bailey.

Professor Scheffer gave some notes on the common mole. Discussion by Sternberg, Harshbarger, Mrs. Smyth, and Dyche.

A. J. Smith read a paper on the water-supply of Emporia. An interesting discussion ensued, participated in by Marvin, Wooster and others.

Mr. Knaus reported additions to the list of Coleoptera. Discussed by Scheffer.

Doctor Dains read a paper on some methylene derivatives.

C. I. Corp reported some tests on the Pelton water-wheel last summer in Madison, Wis.

Doctor Matthews spoke of the Audubon Society, and moved that the Academy recommend an increase in the list of protected birds. So voted.

Meeting adjourned till two P. M.

Reading of papers was resumed after the intermission.

Mr. Dalton read a paper on railroad rates from an engineering standpoint.

Proposition to divide into sections to hasten the completion of the program was decided adversely.

Voted that the time alloted to papers hereafter read in this meeting be limited to ten minutes.

Doctor Wooster gave an abstract of his paper on the germ plasm hypothesis of Weismann.

Professor Willard discussed the difficulties of testing foods for sulfites.

Professor Bailey presented a paper on the sulfides as preservatives.

Professor Young gave a study of the causes of coal-mine explosions. Discussed by Bailey and Willard.

Professor Jones gave a paper on the medullary ray as an element of strength in structural timber.

Professor Todd presented a speculation in crystallography.

Professor Dyche gave a group of three papers: (1) Preservation of skins of mammals. (2) Poison-glands of rattlesnakes in hibernation. (3) A new bird for the Kansas list.

Professor Stimpson spoke of the importance of inspection of weights and measures.

Mr. Moodie presented a list of the Carboniferous quadrupeds of Kansas.

Mr. Cowgill read a paper on the values of feeds for cattle.

C. H. Sternberg gave an account of his expedition last summer to the Laramie beds of Wyoming.

Doctor McWharf read a paper on the prevalence of cancer and its mode of propagation and cure.

H. P. Cady discussed the relation of manganese to the corrosion of iron.

Mrs. Smyth gave some notes on bats.

The committee on nominations reported officers recommended for the ensuing year as follows:

For president, F. B. Dains, Topeka.
For vice-president, J. M. McWharf, Ottawa.
For vice-president, A. J. Smith, Emporia.
For treasurer, F. W. Bushong, Lawrence.
For secretary, J. T. Lovewell, Topeka.

On motion, the rules were suspended and the president cast the Academy's vote for the officers recommended, and declared them elected.

The meeting now adjourned to meet in Carnegie Library, Washburn College, at 7:30 P. M.

CARNEGIE LIBRARY—7:30 P. M.

Professor Edmondson gave an account of his trip to Tahiti last summer. This was beautifully illustrated by views taken on this trip.

Professor Parker followed, with notes on photography of wild birds, also illustrated by projections.

C. H. Sternberg gave some interesting views of his fossil-hunting in Wyoming.

Following the entertainment with the stereopticon, the Academy adjourned for a social hour, and enjoyed the hospitality of the Washburn Faculty and their ladies, partaking of light refreshments, conversing, and listening to some impromptu speaking.

Saturday morning at nine o'clock the Academy met again in the supreme court room.

The committee on resolutions reported the following:

WHEREAS, This Academy has grown to such proportions that it is impracticable to have all the papers presented at the annual meeting read in entirety, and

WHEREAS, It is very desirable to continue encouraging the preparation and presentation of papers to the several meetings of this Academy, and to have them appear in the published transactions; therefore, be it

Resolved, That in the judgment of this meeting, authors of papers should not occupy more than ten minutes in reading any paper presented to this Academy; that longer papers should be read in abstract so as to come within the ten minutes of time, and that our secretary be instructed to put into operation the principles of this resolution in the preparation of future programs; and be it

Further resolved, That the program committee be requested to determine, concerning the remaining papers, on consultation with their authors,

whether their papers shall be read by title or in sectional meetings, or be read in abstract in the general meetings of the Academy.

Resolved, That the thanks of the Academy be extended to the secretary and local committee on arrangements for the facilities secured for the Academy in the state-house.

Resolved, That the thanks of the Academy be extended to the Faculty of Washburn College for the opportunity to meet at the College, and for the courtesies extended to us at the social session. It is

Further resolved, That the thanks of the Academy are due to the daily press of Topeka for the full and generous reports of its daily sessions.

Respectfully submitted.

W. KNAUS,
L. C. WOOSTER,
E. H. S. BAILEY, *Committee.*

By vote, this report was accepted.

The committee on membership reported the following applications for membership in the Academy, and recommended that the persons named be so received:

F. H. Billings, University of Kansas, Lawrence.
E. W. Brown, teacher in high school, Fort Scott.
L. D. Bushnell, bacteriologist, Manhattan.
I. D. Cardiff, professor of botany, Washburn College, Topeka.
W. M. Crotinger, teacher, Rush Center.
S. J. Crumbine, secretary State Board of Health, Topeka.
B. J. Dalton, teacher, Lawrence.
C. H. Edmondson, professor of zoölogy, Washburn College, Topeka.
H. L. Jackson, professor of chemistry, University of Kansas, Lawrence.
F. E. Jones, instructor of manual training, Lawrence.
R. D. Landrum, professor of chemistry, University of Kansas, Lawrence.
B. A. Marcell, teacher, Ottawa.
W. P. McCartney, chemist, Topeka.
J. M. Meade, engineer, A. T. & S. F. Rly., Topeka.
R. L. Moodie, instructor, University of Kansas, Lawrence.
J. B. Parker, entomologist, Agricultural College, Manhattan.
H. A. Rice, professor of physics, University of Kansas, Lawrence.
F. K. Sanders, Ph. D., president of Washburn College, Topeka.
Frank E. Ward, teacher, University of Kansas, Lawrence.
J. F. True, stockman, Topeka.
C. E. Warfel, lawyer, Wamego.
E. A. White, teacher of chemistry, Kansas City.
C. M. Young, engineer, University of Kansas, Lawrence.

On motion, the rules were suspended, and the above-named persons were admitted to membership by vote of the Academy, cast by the secretary.

The president, E. Haworth, gave his retiring address on "The Life History of a River."

Professor Bushong gave results of his researches on mid-continent petroleum.

J. T. Lovewell read a paper on economy of heat in cooking.

J. E. Todd gave an abstract of his paper on the Kansas ice-sheet.

B. B. Smyth presented notes on a captive Heloderma.

C. H. Withington gave abstracts of two papers—one on insect types and co-types in the collection of the University of Kansas, and the other on the habits of parasitic Hymenoptera.

L. A. Kenoyer discussed intercellular spaces in plants.

T. H. Scheffer read a paper on the distribution and habits of gophers.

Mr. Landrum gave an account of the enameling of steel.

Papers numbered 2, 15, 17, 21, 22, 23, 27, 33, 41, 49, 58, 59, 65, 67, 68 and 69 were read by title, and the program now being completed, the president declared the forty-first annual session of the Academy adjourned *sine die.*

Memorial Addresses.

FRANCIS HUNTINGTON SNOW.
WILLIAM ASHBROOK KELLERMAN.

FRANCIS HUNTINGTON SNOW, SCIENTIST.

By E. Miller, Lawrence.

WHEN Oliver Cromwell was sitting for a portrait of himself, he said to the artist, "Paint me as I am." So when one attempts to portray the character and life of another, in order that the picture may be perfect in all its details—nothing added that should be omitted, nothing lacking that should be there—it is easily seen how great a task is to be accomplished. But when the character and the work of such a man as Francis Huntington Snow, whom we all knew and loved, are to be described, the undertaking is a very great one indeed.

To portray him as he lived, as he showed himself in his family and among his fellow citizens; to picture him in his classroom with his students about him, and in his laboratory arranging and classifying the material he had collected among the mountains, on the plains and from the sea, would require in the one attempting it a personal and intimate acquaintance with the man. Nor would the description be complete without the story of his search for new and unknown forms of insect life, or for meteoric bodies; of his exposure to dangers, seen and unseen; of the writing and publishing of his scientific reports; of expeditions made summer after summer; of his daily record of rains and snows, and winds and storms; and of his investigations into the habits of insects in order to save the wheat and corn of Kansas. And over and above all this, there must be shown the indomitable spirit, the intensity of purpose and the unflagging zeal, as well as the great mental and moral qualities, that in themselves constituted the man.

From the day of his birth, in 1840, until he entered Williams College, in 1858, the boy Frank Snow exhibited the same determined, masterful spirit and honorable ambition to win out, the same hatred of shams, and that rugged, vigorous, incorruptible and outspoken sense of honor that ever marked his long and useful career of service. At the age of eighteen he entered college, where for four years the boy gave proof of the stuff that was in him. He seemed to be always keyed up for work or play. And this told in unmistakable terms what kind of man was being fashioned during those four years at college. His thorough mastery of the old classic languages, his clear conception of such scientific subjects as were in the course of study of those days, and his eagerness in

the acquisition of philosophy, history and mathematics, proved how conscientiously and carefully he applied himself to everything he undertook. Outdoor life was to him a constant source of enjoyment. He fairly reveled in the pure air about him. He was a lover of physical exercise, and entered into the sports and games of the athletic field of those days with jaws set and muscles hard and tense, and whether defeat or victory came to him, he accepted either as a gentleman. There was nothing small, nothing mean, about him.

When he graduated he stood at the head of his class and was appointed valedictorian by the faculty. To win such an honor, when among his classmates were General Armstrong, Franklin Carter (afterwards president of Williams College), Prof. E. H. Griffin (of Johns Hopkins University), Prof. George Raymond (of Princeton University), and other notable men, was a great achievement for a boy of twenty-two. His standing as a scholar was at that time the highest ever reached by a student of Williams. All these accomplishments, successes and victories were not obtained by sudden fits of inspiration, but by honest, earnest work, day after day.

When F. H. Snow entered college he was a boy; when he graduated, four years later, he was still a boy; and during the remaining forty-six years of his life he continued to be a boy—the same happy, joyous and free-hearted fellow, year after year.

In 1864 the young man entered Andover Theological Seminary to study for the ministry. He took this step very much against the wishes of his father, who was anxious that his son should be a partner with him in business. To the seminary, however, he went, and during his course there he was often invited to preach in the churches of the neighboring towns. His preaching met with great acceptance, and at last a call came to him to be pastor of the Congregational church at Concord. After the trial sermon, his father, who was in the audience, the most interested man there, was so overcome by his feelings that he kissed his son. From that moment all opposition on the part of his father disappeard. Young Snow, studying theology at Andover, was intensely aroused by the War of the Rebellion, and, fired with a patriotic desire to serve his country, became a worker in the United States Christian Commission, and was assigned to duty at the front upon the battle-fields between Washington and Richmond. Here, as usual, he was ever ready to do his duty. In the hospital, on the field of battle, and everywhere, Snow was to be seen, ministering to the sick, wounded

and dying: speaking words of comfort; writing letters for the helpless soldiers, and treating all alike, white or black, unionist or rebel, with tenderness and sympathy.

During his connection with the Christian Commission the young man kept a diary. The following entry, dated March 31, 1865, was made: "I went to the front to-day when a sharp battle was raging—the battle of Stony Creek—where our loss was about 1000 killed and wounded. The Fifth corps was repulsed and obliged to fall back during the forenoon to the south side of the creek. In the afternoon, however, it recovered the lost ground. The dead and wounded of both sides fell into our hands and presented a sad scene. Men lay on the ground stiff in death, their unclosed eyes turned upward in vacant stare, and their stiffened hands and arms raised toward heaven as if in supplication to God. And O what agony was depicted on the faces of some of our wounded boys. It was an inestimable boon to be allowed to moisten their parched lips with a little cold water from the spring near by, or to note down a few words of farewell from some dying boy to his beloved mother. Surely, man pays a terrible price for indulgence in crime, and no nation ever paid more dearly for its wickedness than our own American people for the enormity of chattel slavery."

Here is another extract: "After the surrender of Lee, I and others this morning effected an entrance through the rebel lines, in order to do which we were obliged to flank the guards. We found ourselves among defiant rebels. All the officers and many of the privates expressed the rankest treason with unlimited boldness. They would fight us again if General Lee would only say the word. They were not whipped but only overpowered; would leave the country unless they could achieve their independence. The South would never submit so long as they could keep an organized force of 5000 men; would turn guerrillas as soon as the main armies had surrendered, and harass the United States into recognition of their independence."

Again: "After a long discussion with Sergeant Gray, of the Seventh Louisiana, in regard to the cause of the war, I finally suggested that after all we had better shake hands and be friends again, letting bygones be bygones, when he immediately straightened his athletic form and with a flood of indignation in his eye, replied: 'Shake hands with you? Never will I shake hands with the man who has shed the life-blood of my dearest friends. Let

bygones be bygones? That I will; all friendship with you shall be a bygone forever.'"

On Sunday, April 9, 1865, he wrote as follows: "The most brilliant page in the military history of our nation has been written to-day in characters that shall never be effaced. The Rebel Napoleon has surrendered to the Wellington Grant, and the rebellion is virtually brought to a close. The enthusiasm of our troops knows no bounds. The air is filled with the sound of glad huzzas as the great news spreads like wildfire from regiment to regiment. All along the lines hundreds of military bands are discoursing martial music, and naught seems lacking to complete the happiness of all."

His work in the army was now over. He laid aside his career as a minister of the gospel and accepted a call from the University of Kansas to occupy a chair in that new institution of learning. The call was made mainly through the influence of Gov. Charles Robinson. Had he been at liberty to choose, he would have taken the chair of the ancient languages, for his training, his tastes and his power of memory fitted him for that kind of work. But the professor cheerfully turned aside from Homer and Plato, and Horace and Cicero, to teach mathematics, geography, natural philosophy, and any other science that might show itself in an embryonic school of fifty-five students in its first year of existence. Little did he dream, and never did his most intimate friends in their wildest imaginings ever think, that in him was the stuff for the making of a great scientific thinker, who was to turn over new pages of science and widen the boundaries of knowledge. What he might have done, how much of the life of ancient Greece and Rome he might have brought to light through persistent research, and what additions he might have made to general literature, no one can tell. A new world and a newer field of knowledge were for forty-two years to be explored by him and the results given to science.

Williams College never did a better thing than when she gave Snow to Kansas, and Kansas never did a greater thing than when she welcomed to her citizenship so great a thinker.

What was it that this man did during the forty-two years of his connection with the University of Kansas? Every Kansan knows the story by heart. Twenty thousand young men and women with one accord testify every day of their lives as to the value of the great institution on Mount Oread, a monument to the genius and guiding hand of this master builder. They know that he was a splendid type of the highest class of educators. Beginning with

mathematics of a very elementary kind, and with natural science in its infancy in the University, he moved forward, introducing into the curriculum, one after another, entomology, meteorology, zoölogy, botany, biology and other kindred subjects; cordially supporting the idea of building into a great school the various departments of civil, mechanical, hydraulic, mining and electrical engineering; assisting in the evolution of a department of chemistry that now ranks among the best of its kind. Soon it was noised abroad that right here on Kansas soil, where only forty-three years before some of the best blood of the land was shed for the sake of liberty, here a great scientific and technical school had sprung into existence. During all this time, the man who was so quietly doing things was at work training a half dozen or more young men who were soon to be heard and talked about all over the scientific world. They are in the University to-day. Two more are in Leland Stanford Junior University, and others still are scattered over the country at work in different departments of science. Governors of states, judges, congressmen, professors of colleges and universities, lawyers, bankers, engineers and farmers have sat at the feet of this wonderful man, learning of him.

In the year 1890 Professor Snow, then a doctor of philosophy and a doctor of laws, was elected chancellor of the University. This act of the board of regents met the hearty approval of the people of the state, and also that of the faculty and the student body. The wisdom of the choice was seen at once in the forward steps taken by the University in all of its relations. It was at this time that an insect known as the chinch-bug was doing immense damage to the fields of wheat and corn of Kansas and of neighboring states. How to prevent the impending ruin was the question uppermost in the minds of men all over the infected districts. Relief came just as despair was settling down upon the farmer. Help was extended from a quarter from which such help is seldom expected. Chancellor Snow obtained a fungus growth which by a process of inoculation was communicated to the living bug. It was found that the fungus growth would spread from bug to bug very rapidly, quickly destroying the pest in the grain-fields in a most thorough manner. The state legislature granted a liberal sum for the purpose of carrying on the process of inoculating bugs under the direction of Doctor Snow, thus placing their seal of approval upon what he was doing. His honest efforts in this direction gained for him the confidence and love of every farmer and almost every citizen of the state. In the museum of natural his-

tory of the University the record of a busy life is to be found—the story of a marvelous career.

In the summer of 1907 Dr. Snow conducted his twenty-sixth and final expedition for the collection of insects among the mountains of Arizona. He returned with more than 12,000 specimens. His first expedition was undertaken in 1872. Generally he had with him members of his own family, students and young scientists, with whom explorations were made in Kansas, Colorado, Texas, New Mexico, Arizona and other sections of the country. In a few years large quantities of plants, insects, mammals, birds, fossils and meteorites were placed in the museums of the University, worth many thousands of dollars and of great scientific value. At the present time the entomological collection contains over 21,000 species and 275,000 specimens of insects, the largest collection in the United States. The entomological expedition of 1903, in southwestern Arizona, brought back nearly 25,000 specimens, and of these there were from 50 to 100 new species. In this collection there were 5430 beetles; 4500 flies; 1926 butterflies and moths; 11,822 bees and wasps; 550 grasshoppers and crickets; 232 bugs; 169 dragon-flies; in all 24,629. It was on this trip that the provisions of the party ran rather low. Flour was about the only thing left when they began to return. Of potatoes there were none for some time, and of butter they were destitute for a month. In relating their experiences, Doctor Snow said: "We took turns at cooking, but I did the baking—that was my job every morning. I baked more than 1500 muffins, and the boys said they were good, too," and the scientist smiled with boyish satisfaction.

But let no one think that the scientific expeditions led by Doctor Snow were mere holidays spent in fun and frolic, and to have a good time. On the contrary, they were often dangerous and full of hazard. They were sometimes in the midst of perils, seen and unseen—snakes, wild animals, Gila monsters and savage Indians, waterspouts and storms. On one occasion, the doctor had caught a small rattlesnake which he was attempting to put into a bottle of alcohol. As it was going in tail foremost, it suddenly stiffened itself and bit one of his fingers. He did not lose his presence of mind for a moment. Nevertheless the snake was bottled, and the doctor began a vigorous sucking of the bitten finger, had a string wrapped tightly above the wound, and continued the sucking process until the finger looked like a piece of dead meat. No serious effects followed.

In the summer of 1881, with a party of three, one of whom was

FRANCIS HUNTINGTON SNOW.

his son William, twelve years of age, he went to Arizona. The Apache Indians were on the war-path, killing the whites, carrying off their provisions and clothing, and driving away their horses and cattle. Intense excitement existed at the University when the news came that the party were in imminent peril of their lives. The anxiety was not allayed until a letter from the doctor arrived. He wrote, August 17, as follows: "Last Saturday afternoon our camp was visited by two citizens of Socorro, who made the trip on horseback at the risk of their lives, to inform us that the reds had murdered two men that morning on the road between our camp and town. Two of them were Mexicans who were going in with a load of wood. The loaded wagon stood in the road as we came by yesterday, and the blood of the murdered men stained the ground —not yet dry. Three white men were killed a mile further on. One other escaped to tell the news—the very man who took us out to the mountains on the preceding Monday. We were on guard day and night for three days—the rifle I bought in Boston coming into requisition for another purpose than for hunting venison and smaller game. We had pickets out by night and scouts by day. The Indians, night before last, came up the canon to within a few rods of our picket-guard, as we knew by the prints of their moccasins on the freshly wet earth. They were also watching us on Sunday from the top of the canon, about 1500 feet above us."

In 1906 Doctor Snow captured in Arizona a specimen of the lizard kind known as the Gila monster. It is asserted by some that the bite of this hideous looking animal is sure death; others declare it to be perfectly innocuous. His experience is that "the effects of a Gila monster bite have been much exaggerated." "Of course," said he, "I have not had so much to do with them. The one that I have planted six teeth securely in my thumb, and I suffered no ill effects."

Many other incidents might be related, but the foregoing are enough.

At the University Doctor Snow's time was taken up in the work of the recitation room, in delivering lectures, in correspondence with men of science in both Europe and America, and in arranging and classifying the thousands of insects, beetles and butterflies that he had collected. On many of his expeditions he made rare finds—some that were entirely new to science, and some to which by common consent his name was attached.

When Doctor Snow entered upon his administrative duties as the head of the Kansas University he was fifty years old. Robust,

and strong in mind and body, he cheerfully but hesitatingly undertook the task of building upon the foundation already laid a great institution of learning. He was a firm believer in the co-education of the sexes. In that he never wavered. At the beginning of his administration as chancellor, the University was divided into schools—the College of Liberal Arts and Sciences, the Engineering School, the School of Law, the Graduate School, and three or four others. The board of regents placed at the head of each school a dean, with certain duties and reponsibilities. The head professors were allowed the largest latitude in the management of their respective departments. A very marked improvement along all lines was noticeable. The state legislature increased its appropriations, new buildings were erected, new members of the faculty were called to assist in the ever increasing labor, and more students swarmed through its halls.

The man at the head was instant in season and out of season. With him it was the University first, last, and all the time, and the University received the best that he had to give. Those who were closest to him were astonished at the marvelous capacity of the man. Lines of care soon began to make their appearance upon that young face. Weariness settled down upon that vigorous frame, and, to add to the burdens, his oldest son, William Appleton Snow, was drowned in the Bay of San Francisco, in the discharge of his duty as a newspaper reporter, at the time of the return of the Twentieth Kansas regiment from the Philippine Islands. It was a stunning blow, from which the doctor never fully recovered. Worn out and broken in health he went to Europe for a year to recover if possible his old-time vigor. On his return he resumed his duties as chancellor, apparently as strong as ever in both body and mind, but, finding the work heavier than he had anticipated, he resigned in 1901. The board of regents, however, reelected him to his former chair in the University. He at once resumed his duties among the butterflies, moths and beetles, and making his reports of Kansas weather. He enjoyed it. Frequently he was heard to say, "How happy I am, now that I am relieved of the chancellorship, and can do the work that I love best." He still looked forward to many days of usefulness; his eye seemed to be as keen as that of an eagle, his mind as bright and clear as ever, and his intercourse with his family and friends as free as in the days of old. But the burdens, the anxieties, and the cares of a busy life could no longer be cast aside. He was compelled to desist from his labors. He went North and East, only to meet every-

where an enemy that would not down at his bidding. It was a terrific struggle. On the 21st of September, 1908, the end came, and a great soul went across "the bar." His wife, Mrs. Jane Appleton Snow, to whom he was married in 1868, one son and three daughters survive him.

Doctor Snow was one of the seventeen men who organized the Kansas Academy of Science, in 1868, and he continued to be an active member all his life. He published in the Transactions of the Kansas Academy over 100 scientific articles. He wrote for other scientific journals and magazines, among them the American Naturalist, Science, Transactions of the Kansas Historical Society, Kansas Educational Journal, Bulletin Nuttali Ornithological Club, and Kansas Science Bulletin.

The trend of Doctor Snow's mind and tastes was along the lines of natural science. Nature was to him an open book, which he read with ever-increasing interest. He was a crowned prince in the realm of nature.

Doctor Snow was a member of many scientific societies. He corresponded with men of science in other lands, and was recognized as a scientist of high rank. His praise was upon the lips of men everywhere. Only a little while ago, a widely celebrated man remarked of Doctor Snow: "What a grand, glorious, wonderful man he is." Snow Hall was named in his honor. The Spooner Library building was erected out of funds left to the University by his uncle, W. B. Spooner, of Boston. The bequest was made because Doctor Snow was in the Kansas University. He saved to the state of Kansas hundreds of thousands of dollars by his discovery of the chinch-bug fungus. The collections that he made from year to year, now in the museum of natural history, have a monetary value of not less than a hundred thousand dollars. Truly, the state of Kansas is a debtor to this her first scientist.

Dr. Snow lived a blameless life, at peace with all mankind, happy in his family relations, a true Christian—loving God and loving man. He was an earnest, zealous student, a profound scholar, a seeker after truth in the laboratory, in the fields and in the air. In his official character as professor or as chancellor he was a fair and square man, and no respecter of persons. He loved his country and was willing to die for her. He loved Kansas, to which he gave all that he had.

He was more largely instrumental than any other man in the upbuilding of the University of Kansas. For forty-two years he watched over its growth and in many ways directed its progress.

He more than any other gave to the University the lofty position it now holds in the advancement and dissemination of science. As a matter of fact, Doctor Snow had caught the modern scientific spirit on the wing. He impressed it upon all who came under his instruction. Early in his undergraduate course at Williams College he felt its power. Later on, when he was with Agassiz at his marine laboratory, it became more fully developed. Finally, in the University, and on the western plains and mountains, he was under its complete control. It was the passion of his life. No one will question the assertion that at the time of his death Doctor Francis Huntington Snow was the first citizen of Kansas, and as such his name and fame will be more enduring than a monument of brass or marble.

THE SCIENTIFIC PAPERS OF DR. FRANCIS HUNTINGTON SNOW.

By F. O. Marvin, Lawrence.

The following bibliography of the scientific writings of Doctor Snow has been based largely upon a list that he himself prepared some years ago. It has been added to and brought down to include his latest work, all the material that could be found being gathered. In the summary given no account is made of the monthly reports of weather conditions at Lawrence, which reports have regularly appeared in sundry papers of the state. The annual reports were counted. The mere statistics of these weather observations show nothing of the faithful and constant daily care of making them. It was a personal matter with Doctor Snow, looked after by himself, some member of his family, or by some one under his immediate supervision. It is this personal element that makes this long series, extending over forty years, an accurate and therefore a very valuable record.

No mention is made in the bibliography of "The Observer of Nature." This was a small periodical, devoted to natural science, edited by Doctor Snow, and published at the University, where it had a real influence in developing a genuine scientific spirit. It was started in the early '70's and was issued for several years.

Doctor Snow possessed a simple and direct style, expressing his thought with clearness and in good diction. His writing as well as his speech showed energy and enthusiasm. It could not be otherwise, for these were qualities that were ingrained in the very nature of the man.

LIST OF SCIENTIFIC PAPERS.

1868 to 1908.

Complete series of monthly and annual meterological reports from 1868 to the present time, based upon personal observations for that period. The reports are published monthly in bulletin form, and republished in many state papers. Annual reports are published in the biennial reports of the State Board of Agriculture.

Also, 15 papers published in Trans. Kan. Acad. Sci., I to XII.

The Study of Plants. Kan. Ed. Jour., V, pp. 4-6.

1870.+

Natural Science a Necessity in our Public Schools. Kan. Ed. Jour., VII, pp. 144-151.

Catalogue of Plants Seen in Kansas by J. H. Carruth, with Dr. F. H. Snow and E. Hall. Trans. Kan. Acad. Sci., I.

1871.+

The Higher Education of Women. Kan. Ed. Jour., VIII, pp. 307-321.

The Birds of Kansas. Read at fourth meeting Kansas Academy of Science.

1872.+

Catalogue of the Birds of Kansas. Trans. Acad. Sci., I, pp. 375-386 (282 species enumerated); Kan. Ed. Jour., April, p. 8; Trans. Kan. St. Bd. Agri.

The Climate of Kansas. Trans. Kan. Acad. Sci., I, pp. 397-407; Trans. Kan. St. Bd. Agri.

The Claims of the Natural Sciences. Kan. Ed. Jour., pp. 253-263. Read at fourth meeting Kansas Academy of Science.

A Catalogue of the Birds of Kansas, second edition. Kansas City *Bulletin*, steam book and job printers and engravers; a pamphlet of 16 pages.

Additions to the Catalogue of the Birds of Kansas. Am. Nat., VI, pp. 484.

1874.+

Observations on the Use of the Antennæ of *Polyphylla variolosa* Harris. Trans. Kan. Acad. Sci., III, pp. 27, 28.

Additions to the Catalogue of Kansas Birds. Trans. Kan. Acad. Sci., III, pp. 30, 31 (9 species added).

1875.+

Third edition of Catalogue of Kansas Birds. An. Rep. Kan. St. Bd. Agri., IV, pp. 128-139 (295 species enumerated).

The Rocky Mountain Locust, *Caloptenus spretus* Uhler. Trans. Kan. Acad. Sci., IV, pp. 26-28.

The Fishes of the Kansas River at Lawrence. An. Rep. Kan. St. Bd. Agri., IV, pp. 139-141. Read at third meeting of State Natural History Society, 1870.

The Larva and Chrysalis of the Sage Sphinx, *Sphinx lugens* Walker, (*Eremitoides Streckerr*). Trans. Kan. Acad. Sci., IV, pp. 28, 29.

Catalogue of the *Lepidoptera* of Eastern Kansas. Trans. Kan. Acad. Sci., IV, pp. 29-59 (503 species enumerated).

The Best Means of Defense against the Insect Enemies of the Horticulturist. Trans. Kan. St. Hort. Soc., V, pp. 104-112.

1876.

List of Coleoptera Collected in Colorado in June, July and August by the Kansas University Scientific Expedition. Trans. Kan. Acad. Sci., V, pp. 15-20 (enumerates 304 species).

The Relation of Birds to Agriculture. Trans. Kan. St. Hort. Soc., VI, pp. 62-75.

1877.

Addition to the Catalogue of Kansas Birds. Trans. Kan. Acad. Sci., VI, p. 38 (enumerates 7 species and 2 varieties).

Amblychila cylindriformis Say. Trans. Kan. Acad. Sci., VI, pp. 29-32.

The Insects of Wallace County, Kansas. Trans. Kan. Acad. Sci., VI, pp. 61-71 (Coleoptera, 316 species; Lepidoptera, 45 species).

Hunting *Amblychila*. Am. Nat., XI, pp. 731-735.

List of Lepidoptera Collected in Colorado in June, July and August by the Kansas University Scientific Expedition of 1878. Trans. Kan. Acad. Sci., VI, pp. 70-75 (enumerates 104 species).

List of Coleoptera Collected near Dome Rock, Platte Cañon, Colorado, by the Kansas University Scientific Expedition for 1878. Trans. Kan. Acad. Sci., VI, pp. 75-76 (enumerates 94 species).

1878.

On the Dermal Covering of a Mosasauroid Reptile. Trans. Kan. Acad. Sci., VI, pp. 54-58; pl. I, Kan. City Rev. Sci.

1880.

The Climate of Kansas. Sec. Bien. Rep. Kan. St. Bd. Agri., VII, pp. 462-475.

List of Lepidoptera Collected near Idaho Springs, Colo., by the Kansas University Scientific Expedition for 1879. Trans. Kan. Acad. Sci., VII, pp. 61-63 (enumerates 180 species).

List of Coleoptera Collected in Santa Fe Cañon, New Mexico, by the Kansas University Scientific Expedition. Trans. Kan. Acad. Sci., VII, pp. 70-73 (enumerates 237 species).

Douglas County Additions to the List of Kansas Coleoptera in 1879–'80. Trans. Kan. Acad. Sci., VII, pp. 78, 79 (enumerates 144 species).

Preliminary List of the Hymenoptera of Kansas. Trans. Kan. Acad. Sci., VII, pp. 97-101 (enumerates 186 species).

Additions to the List of Kansas Lepidoptera. Trans. Kan. Acad. Sci., VII, pp. 102-105 (enumerates 140 species).

Larva of *Eurycreon rantalis* Quen (Web-worm). Psyche, III, p. 127.

1881.

List of Lepidoptera and Coleoptera Collected in New Mexico by the Kansas University Scientific Expedition. Trans. Kan. Acad. Sci., VIII, pp. 35-46 (315 species Lepidoptera, 53 sp. nov.; 514 Coleoptera, 17 sp. nov.)

1882.

Additions to the List of Kansas Coleoptera in 1881–'82. Trans. Kan. Acad. Sci., VIII, p. 58 (49 species).

On *Musca domestica* versus *Vespa occidentalis* Cresson. Psyche, III, p. 339.

1882.

A New Museum Pest, *Trogoderma tarsale*. Psyche, III, pp. 351, 352. June.

The Snake Bird in Kansas. Bull. Nuttall Ornithological Club, VII, p. 61.

1883.

Three Noxious Insects—the Forest Handmaid-moth, the Maple-worm, and the Codling-moth. Second Quart. Rep. Kan. St. Bd. Agri. pp. 93–101.

Hominivorous Habits of *Lucilia macellaria*, the Screw-worm. Psyche, IV, pp. 27–30.

Three Injurious Insects—the Tree-cricket, the Raspberry Saw-fly, and the Screw-worm. Mo. Rep. Kan. St. Bd. Agri. for May, pp. 6–12.

Injurious Insects and How to Destroy Them. First Quart. Rep. Kan. St. Bd. Agri., pp. 39–48.

1884.

Insects Injurious to Wheat. Fourth Bien. Rep. Kan. St. Bd. Agri., IX, pp. 604–611, pls. I, II.

Preparatory Stages of *Hyperchiria zephyria*. Grote. Trans. Kan. Acad. Sci., IX, pp. 61, 62.

List of Lepidotera and Coleoptera Collected in New Mexico by the Kansas University Scientific Expedition of 1883–'84. Trans. Kan. Acad. Sci., IX, pp. 65–69 (Lepidoptera 82, Coleoptera 148).

Paris Green, London Purple and Pyrethrum as Insecticides. Mo. Rep. Kan. St. Bd. Agri. for April, pp. 19–27.

Is the Rainfall of Kansas Increasing? Trans. Kan. Acad. Sci., IX, pp. 101–103.

1885.

On the Discovery of a Fossil Bird-track in the Dakota Sandstone. Trans. Kan. Acad. Sci., X, pp. 3–6, pl. I.

Injurious Insects from July to September—the Hessian Fly, the Wheat-straw Worm, the Corn-root Worm, the Strawberry-root Worm, and the Grape Phylloxera. Quart. Rep. Kan. St. Bd. Agri. for quarter ending December 31, pp. 152–157.

The Chinch-bug. Fifth Bien. Rep. Kan. St. Bd. Agri., X, pt. II, pp. 153–157.

Pear Blight. Rep. Kan. St. Bd. Agri. for quarter ending March 31, pp. 9–13.

Injurious Insects—the Hessian Fly, the Wheat-straw Worm, and the Web-worm. Mo. Rep. Kan. St. Bd. Agri. for June, pp. 5–18.

Is the Rainfall of Kansas Increasing? Science, January 2, pp. 12, 13.

1887.

The Purslane Worm, *Copidryas gloveri* Grote. Science, X, p. 158.

Loco-weed. Science, January 28, p. 92.

Is There a Venomous Lizard? Science, XI, p. 50.

Is the Rainfall Increasing on the Plains? Science, XI, p. 158.

Aechmophorus occidentalis in Kansas. Auk., V, p. 201.

1888.

On the Discovery and Significance of Stipules in Certain Dicotyledonous Leaves from the Dakota Rocks. Trans. Kan. Acad. Sci., XI, pp. 33–35.

The Logan County Nickel Mines. Trans. Kan. Acad. Sci., XI, pp. 39–42.

Three New Kansas Birds. Trans. Kan. Acad. Sci., XI, pp. 62–63.

A Comparison of the Records of the Two Anemometers at the University of Kansas. Trans. Kan. Acad. Sci., XI, pp. 107–109.

The Chinch-bug, *Blissus leucopterus* Say. Rep. Kan. St. Bd. Agri. for quarter ending March, pp. 127–131; Sixth Bien. Rep., same, pp. 205–208.

Insects Injurious to Wheat - the Hessian Fly and the Fall Web-worm. Fourth Bien. Rep. Kan. St. Bd. Agri., pp. 604–611.

1889.

The Chinch-bug. Proc. Eighteenth An. Meeting Kan. St. Bd. Agri., Jan , pp. 78–81.

On Experiments for the Artificial Dissemination of a Contagious Disease Among Chinch-bugs. Trans. Kan. Acad. Sci., XII, pp. 34–37.

Polluted Water. Fifth An. Rep. Kan. St. Bd. Health, pp. 337–343.

The Mode of Respiration of the Common Salamander, *Amblystoma mavortium.* Trans. Kan. Acad. Sci., XII, pp. 31–32, fig.

The Curve of Mean Daily Temperature for Twenty Years (1886–'88) at Lawrence, Kan. Trans. Kan. Acad. Sci., XII, pp. 52–53.

1890.

Notes on Some Kansas Meteorites (Kiowa county). Science, XVI, May 9; Trans. Kan. Acad. Sci., XII.

Description of the Washington county, Kansas, Meteorite. Science, XVI, July 18.

Experiments in 1890 for the Destruction of Chinch-bugs in the Field by the artificial Dissemination of Contagious Disease. Seventh Bien. Rep. Kan. St. Bd. Agri., XII, pt. II, pp. 184–188.

Experiments in 1890 for the Artificial Dissemination of Contagious Diseases Among Chinch-bugs. Trans. Kan. Acad. Sci., XII, pp. 119–122; Proc. Eighteenth An. Meeting Kan. St. Bd. Agri., pp. 142–144.

The Chinch-bug. Fifth Bien. Rep. Kan. St. Bd. Agri., p. 155.

Inaugural Address as Chancellor of the University. Commencement Addresses, pp. 21–48.

Another Meteorite from Kiowa County, Kansas. Science, XVI, pp. 39–40.

1891.

Insects Injuring Kansas Wheat. St. Bd. Agri., April, pp. 7–10.

Experiments for the Destruction of Chinch-bugs in the Field by the Artificial Introduction of Contagious Diseases. Insect Life, III, pp. 279–284.

Contagious Diseases of the Chinch-bug. First An. Rep. Exp. Sta., University of Kansas, pp. 1–219, pls. I–III.

A New Kansas Meteorite (the Tonganoxie). Science, XVII, p. 3.

1892.

Contagious Diseases of the Chinch-bug. Second An. Rep. Dir. University Exp. Sta., pp. 1–56.

The Chinch-bug Disease and Other Notes. Insect Life, IV, pp. 69–72.

Chinch-bug, Experiments in 1892 for their Destruction by Disease. Eighth Bien. Rep. Kan. St. Bd. Agri., pt. II, pp. 248-255.

Two Grain Insects. Bull. Dept. Etom., University of Kansas, pp. 1–10, pl. (with V. L. Kellogg).

Experiments for the Destruction of Chinch-bugs by Infection. Psyche, VI, pp. 225-233.

1893.

The Contagious Disease of the Chinch-bug. Third An. Rep. Exp. Sta., University of Kansas, pp. 1–247, pl. IV.

1894.

Contagious Disease of the Chinch-bug. Fourth An. Rep. Exp. Sta., University of Kansas, pp. 1–50, pls. I–IV.

Work in Economic Entomology at Kansas University for the Season of 1894. Insect Life, VII, pp. 141–144, figs.

Results of Chinch-bug Experiments. Quart. Rep. Kan. St. Bd. Agri., March, pp. 108–115.

Periodicity in Kansas Rainfall and Possibilities of Storage of Excess of Rainfall. Ninth Bien. Rep. Kan. St. Bd. Agri., pp. 338–340.

The Doctrine of Evolution, Commencement Address at Howard Payne College. Howard Payne Exponent, V, pp. 216–235.

1896.

Contagious Disease of the Chinch-bug. Sixth An. Rep. Dir. University of Kansas Exp. Sta., pp. 1–39, pls. I–IV.

Popular Education in Europe. Rep. Kan. St. Bd. Agri., March, pp. 216-221.

1897.

The More Destructive Grasshoppers of Kansas. Bull. Dept. Entom., Oct., pp. 1-17, pls. I–IV (with S. J. Hunter).

1900.

The Beginnings of the University of Kansas. Trans. Kan. St. Hist. Soc., VI, pp. 70–76.

1903.

Notes on the Birds of Kansas, and a revised catalogue. Trans. Kan. Acad. Sci., XVIII.

1904.

Notes on Kansas Birds. Trans. Kan. Acad. Sci., XIX.

1905.

Notes on Kansas Birds. Trans. Kan. Acad. Sci., XIX.

Some Results of the University of Kansas Entomological Expeditions to Galveston and Brownsville, Tex., in 1904 and 1905. Trans. Kan. Acad. Sci., XX, pt. I.

Some Results of the University of Kansas Entomological Expeditions to Arizona in 1904 and 1905. Trans. Kan. Acad. Sci., XX, pt. I.

1906.

Additions to the List of Kansas Birds. Trans. Kan. Acad. Sci., XX, pt. II.

Change in the Climate of Kansas. Trans. Kan. Acad. Sci., XX, pt. II.

Is the Gila Monster a Poisonous Reptile? Trans. Kan. Acad. Sci., XX, pt. II.

List of Species of Hymenoptera, collected in New Mexico, 1883–'84; Kansas Entomological Expeditions of 1902, 1903, 1904, 1905, 1906. These collections were made at several points in Arizona. Trans. Kan. Acad. Sci., XX, pt. II.

SUMMARY.

Meteorolgy.—A complete series of monthly and annual reports on the weather at Lawrence, from 1868 to 1908; 40 annual reports. Also, 24 papers.

Ornithology.—16 papers, of which 9 are lists of birds known in Kansas.

Entomology.—58 papers, of which 16 are lists of collections at various times and places, 11 relate to structure or habits, and 31 to the economic influence and importance of insects.

Fishes.—1 paper.
Reptiles.—4 papers.
Botany.—4 papers.
Meteorites.—4 papers.
General Science.—3 papers.
Education.—7 papers.
A total of 161 papers; 63 papers before the Kansas Academy of Science.

PROFESSOR SNOW AS A TEACHER.

By W. C. Stevens, Lawrence.

We can best understand Professor Snow as a teacher by calling to mind the conditions under which his reputation in this field was made. This was before he was called to the chancellorship in 1890, when the daily sessions extended from nine o'clock till one, leaving the rest of the day to be used as the teacher chose. He elected to return after dinner and work in his museum until supper time. Again, we must recall how many branches of study he undertook to teach. They were zoölogy, botany, geology, physiology, meteorology, and comparative anatomy. It is clear enough that building up the museum as he did, and carrying on these numerous branches of science in the classroom, his reputation could not be achieved by profound scholarship in any one of them. Nevertheless, it is very clear to any one who was familiar with the inside of the University in what we now call the old days, that Professor Snow had a reputation as a teacher second to none, and he was considered our big man amongst the students and abroad over the state.

Let us hark back, and in memory enter his classrooms and see him at work there. We see his room filled with students. We see him enter with sprightly step and smiling face. A friendly feeling between teacher and students pervades the room. The roll is called, the text-book is opened on the teacher's desk, and the recitation begins. Questions on the day's lessons are asked clearly and forcibly; the ineffective answer is passed over without reproach, and the successful one is rewarded with a smile. Thus the hour of friendship and good will is passed, and the students feel a surprising amount of interest in the subject, considering the character of the text-books then in vogue; for it must be admitted that they were about as barren and dry-as-dust as such things well could be. They were the dry skeletons of science swinging and creaking in the wind; but in the classroom the rare personality of the teacher draped them about until they became comely, and, for the moment, fair to behold. About half of the time in elementary

zoölogy and botany was spent in the laboratory, where enough gross anatomy was looked into to enable the students to find the scientific names by means of Gray's Manual and Jordan's Manual of the Vertebrates.

It was, of course, a physical impossibility, with classes as large as Professor Snow had, for him to spend much time with any one student, and the renowned method of Agassiz had to prevail. A single class filled the south and west rooms now occupied by the Greek museum, and although one of these rooms lacked the teacher's presence for half of the time order and diligent work prevailed. Once, the writer remembers, the boys barricaded the door between the two rooms with a movable blackboard and proceeded to indulge in horse-play. The teacher forced his way in and stood at the entrance laughing. The boys applauded and settled back into good order without a word of remonstrance or reproach from the teacher, and nothing of the kind again occurred.

Extensive as was the ground covered by Professor Snow's teaching in the latter part of the '80's he broadened it still more, adding animal histology, plant histology, entomology and systematic botany; and this was at a time when he had but one assistant, whose time and interest were mainly devoted to the museum. One wonders at Professor Snow's courage in this. It must be remembered that throughout his own college course he had devoted himself to the classics and mathematics, and he had undertaken the work in science here without any technical preparation. The use of the microscope and the whole German scientific literature were sealed books to him; nevertheless he pushed eagerly into the then newest fields of his sciences, equipped his department with microscopes and gave instruction to large classes of students where he himself was in the first stages of learning. One phase of his character permitted him to do this without serious danger to himself or his students—his absolute frankness and honesty, which kept him from misleading where he was not sure of his ground.

Thoughts of this phase of his character call to mind his attitude towards evolution, which, when he espoused it, was a very unpopular cause. Without a college training in biology, nevertheless his clear and logical mind was able to perceive the soundness of Darwin's conclusions, even at a time when the great Agassiz was withholding his approval. And with conviction once attained Professor Snow never faltered in his fidelity to it. His annual lectures on evolution at the University were enthusiastic, clean-cut, and convincing to the unprejudiced mind.

A word must be said about his lectures before the students in the various courses. His course in physiology and hygiene was entirely a lecture course, and he occasionally lectured in the other courses. The lectures were clear, simple, and straightforward, and were delivered in a charming manner.

What was the secret of Professor Snow's success as a teacher? There was no secret about it. Clear as day it was due to his personality. He was friendly, he was kind, he was patient, he was honest, he was lucid and forceful in speech, he was enthusiastic; and above all and under all was his manliness and fearlessness. These characteristics won for him the respect, the admiration and the affection of the hundreds of students who came under his tutelage. In after-years we loved to recall, not so much that we had studied botany and zoölogy at the University, as that we had studied them under Professor Snow.

FRANCIS HUNTINGTON SNOW MEMORIAL.

By Prof. E. H. S. Bailey, Lawrence.

The professor and scientific investigator to whose name we do honor to-night was foremost in all the activities that have to do with scientific life at the State University. Doctor Snow was one of the six charter members of the Iota chapter of the society of the Sigma Xi, which was founded at the University in 1890. Four of the members, although more than eighteen years have elapsed, are still members of the University faculty. He frequently contributed papers for the edification of the society, especially on his favorite topics meteorology and entomology, as well as graphic descriptions of his scientific expeditions. Not long before his health began finally to fail he entertained the society at his home, and gave a very complete history of the chinch-bug investigation. Doctor Snow was for some time vice-president of the Sigma Xi, and, later, president for a term of two years.

Some of the older students will remember Doctor Snow better as a member of the original Science Club, which met on Friday evenings to discuss general scientific subjects. In looking over the files of the annual meetings for the presentation of original work done by the different departments, his name is found as a frequent contributor. His enthusiasm at the Science Club meetings was contagious, and the result is seen to-day in the biological students all over the country, who were first inspired to scientific research by his voice and example.

The students of the late '80's will not readily forget how Doctor

Snow entered into the spirit of the occasion at the Science Club "It." Here professorial dignity was for the time laid aside, and the members vied with each other in writing, and, sometimes, in acting vigorous burlesques of the formal scientific papers of the year.

The firm hand-grasp, the hearty greeting and the unselfish help that Doctor Snow gave in all scientific activities will always be missed in Lawrence.

By J. W. BEEDE, Bloomington, Ind.

To the minister and teacher is given the privilege of teaching by precept, but to the teaching investigator is given the rare privilege of teaching by example. It is this example that inspires the sincere and able student to a life of devotion to the discovery of new truths for the benefit of mankind. To Professor Snow more than to any other person we must look as the father of scientific research in Kansas and the West. In his death it suffers an irreparable loss.

By A. H. THOMPSON, Topeka.

I do not deem myself worthy to discuss the topic before us, but cannot refrain from adding my tribute to the memory of our dear friend, from the standpoint of the amateur and the layman. He was, in a special sense, the friend and helper of the amateur, and never tired of giving his time and attention to the uninformed seeker after the truth. I recall with pleasure his many visits to my house, when we would sit far into the small hours, discussing scientific topics, and especially the exciting and weighty questions of evolution and Darwinism, which were occupying the attention of the scientific world.

But it is of his charming and winsome personality that I wish most to speak. His was a most sweet and winning character, and that was a power with him everywhere. I can easily understand his success in the classroom, for he drew the students to him, as he did every one, and invested the dry facts of science with an interest that remained a blessed heritage with them ever afterwards. I well remember the dedication of Snow Hall, which I had the pleasure of attending. I remember how the students carried Professor Snow on their shoulders to the hall and back, and how he enjoyed it as much as any of the boys. Prof. F. D. Cope, the brilliant paleontologist of Philadelphia, gave the address, and we went to dine at Professor Snow's with him and spent a never-to-be-forgotten day.

The cause of science and of the Academy owes more to Profes-

sor Snow in the cause of making them popular with the people at large than can be realized. With Professor Mudge, who was also popular with the people, much more is due to him than can ever be estimated. Such as he it is that add to the pleasures and enthusiasms of life and make the world the better for having lived in it.

DOCTOR SNOW AS TEACHER.

By L. E. Sayre, Lawrence.

It would be impossible for me, in the time which I feel allowed to occupy, to express in detail the thoughts that come to me as one who has the privilege of referring to Doctor Snow as an instructor. I should be glad if time were allowed to recount the delightful experiences with him as a teacher, and to recount the many ways in which he was a help and inspiration in the work of my own special department. When the School of Pharmacy was organized, in 1885 he was one of the first to contribute to the development of the curriculum and materially to aid in the instruction, taking upon himself the work in botany in its various branches.

It is needless to say that the students coming in contact with such a man as Doctor Snow felt themselves always in the presence of one who could speak with authority, and thus add a power and impetus to the work which few men are so capable of giving.

My own experience with Doctor Snow as an instructor has been that of a pupil rather than as a colleague. Although associated with him in the latter capacity since my connection with the University, I never could regard him other than as a leader. As a teacher, his pupils could never feel a discouragement in the consciousness of their own ignorance, because Doctor Snow's belief was that this consciousness of the lack of knowledge, which he confessed himself to keenly feel, was a good sign of a true student.

There are those who are satisfied to be instructed by books alone. Doctor Snow's method was that of books supplemented by reason and experience. With him the earth, the woods and the wayside teemed with instruction and knowledge. He often expressed the thought that he loved nature because he thought it was so truthful, and never led the honest student astray. If you investigate nature it conceals nothing; if you do not interpret it rightly, it is charitable—is never reproachful. But nature is a faithful, patient master, ready to instruct, not with the harsh discipline of the tutor, but with the allurement which invites investigation and brings with it inspiration. So imperceptible is nature's teaching that one is

unconscious of being taught. This was Doctor Snow's temper toward a scheme of instruction. My impressions of Doctor Snow, as a teacher can be expressed in no better way than to say briefly, teaching with him was a delightful task, and instruction from him was a delightful incentive and inspiration.

DOCTOR SNOW AS A COLLECTOR, AND HIS COLLECTIONS.

By Prof. L. L. Dyche, Lawrence.

In the Quarter Centennial History of the University of Kansas, in an article entitled "Reminiscences," Prof. D. H. Robinson, who commenced work in the institution as a colleague of Doctor Snow, gives us the following interesting information:

"Our learned professor of natural history, who has now achieved more than a national reputation in his special line of work, came to the University with the expressed desire of teaching the Greek language and literature. To this end, more perhaps than any other, had tended all his previous training. A severe classical course in college, with special attention to Greek, and a three years' course in Andover Theological Seminary, with critical study of Greek and Hebrew, had given him especial fondness and capacity for linguistic studies.

"His knowledge of the natural sciences, on the other hand, was mostly negative—only the smattering that was then taught in the New England classical college—just enough to make the 'darkness visible.'

"He brought to the duties of his professorship, therefore, no special training in science, but only the natural endowments of a sound, vigorous mind, sharpened by classical studies, keen powers of observation, a passion for knowledge, untiring energy, and boundless capacity for hard work. Thus equipped, he was elected professor of mathematics and the natural sciences."

In this same article it is further stated that the first scientific excursion undertaken by Professor Snow was made on Friday afternoon, September 4, 1866. The entire faculty of the University (consisting of three persons, President Rice, Professors Robinson and Snow) went on horseback up the river to Cameron's Bluff to examine some petrified turtles (presumably geodes) that had been reported as seen in that locality.

It was while sitting by a camp-fire one evening in New Mexico that Professor Snow, speaking of his first interest in natural history work and his collections, told the writer that the first specimen

he ever collected and saved was a snake. He put the snake in a jar of alcohol and placed it on the mantel. He said that his father, referring to it, facetiously called him a professor of one snake. He said further that a prairie-chicken hunt that he and Professor Robinson took in the fall of 1866, while waiting for the first term of the University to open, gave him his first ideas about collecting and studying birds.

The oldest specimen I have been able to find in the University natural history museum, collected by Doctor Snow himself, is a snow goose, taken in April, 1870. In 1871, 1872 and 1873 a considerable number of bird-skin specimens were collected by Doctor Snow and his student assistants. While he was a keen student of birds, he never saved but a few skins, and mounted no specimens with his own hands.

Among his earliest collections were insects. These, as well as other natural history specimens, were first collected to illustrate lectures in the classroom. As he taught classes in nearly every branch of natural history, he thus laid the foundation for the magnificent collections the University now possesses. As his work progressed he made many reports to this Academy, and its pages are full of lists of specimens (especially of insects) which he secured on his various expeditions. However, his first paper was on "The Fishes of Kansas River," and was read before the Academy September 6, 1870.

In 1871 he read his first paper on "The Birds of Kansas," and in September, 1873, he read his first paper on insects, entitled "The Lepidoptera of Kansas."

SCIENTIFIC EXPEDITIONS.

We will now give a brief account of the twenty-six scientific expeditions which Doctor Snow made during the forty-two years he was connected with the University. More or less complete records of fourteen of these expeditions have been published in the proceedings of this Society. They extended over parts of western Kansas, Colorado, southwestern Texas, New Mexico and Arizona. The chief object of these excursions was to make collections of insects, though he was interested in nearly every branch of natural history, and encouraged his assistants and students to collect birds, mammals, reptiles, fishes and plants, as well as specimens of rocks, minerals and fossils.

1. The first collecting trip that Doctor Snow made, outside of the vicinity of Lawrence and Douglas county, was in 1876, to Colorado Springs and Pike's Peak. Five members of the gradua-

ting class of that year organized a scientific expedition for "exploration in Colorado." Professor Snow was invited to accompany the expedition. During the first week of August the student members of the party returned home. Professor Snow, his wife and son Willie—then about eight years old—remained until September 1. (Kan. Acad. Sci., vol. V, p. 15.)

2. In 1877 Professor Snow conducted an expedition to Wallace county, Kansas. He spent three weeks in camp along the Smoky Hill river, about one mile from Fort Wallace. His assistants on that trip were Richard Foster and John M. Walker, students of the University. It was that year that the party collected about 1500 specimens of the then rare species of tiger-beetle, *Amblychyla cylindriformis.* In 1876, the year previous, these beetles were reported to have sold at from five to fifteen dollars for a single specimen. Doctor Snow's immense catch put the market price down to one dollar, and take your pay in other insect specimens at their listed values. (Kan. Acad. Sci., vol. VI, p. 61.)

3. In 1878 Professor Snow, and Prof. B. F. Mudge, of the department of geology at the Agricultural College, made an expedition to Gove county, Kansas, for the purpose of collecting fossils from the chalk-beds of that locality. Richard Foster and L. L. Dyche, students at the University, were assistants on that expedition. The expedition spent about a month in Gove county. It was on that trip that Professor Snow was bitten by a rattlesnake. After carrying the snake about camp for some time and convincing himself that it was harmless if treated kindly, one day, about noontime, he undertook to put the reptile in a jar of alcohol, tail first. He was holding the snake by the neck with not more than an inch of the reptile's head protruding beyond his thumb and finger. However, about the time the snake's tail struck the alcohol the reptile managed to twist its head enough to bite the professor on the finger. The writer immediately tied a piece of shoe-string, the most available string on hand, tightly around the finger, and lanced the bite with a pocket-knife. Another member of the party immediately began sucking the finger so as to remove the poison. Either the treatment was very effective or the snake, being a small one, had little poison in its glands, for the professor was not injured, and in less than two hours was out collecting as usual. (Kan. Ac. Sci., vol. VI, p. 75.)

4. During the month of August in the same year (1878), Professor Snow and the students who were with him in Gove county, Kansas, spent about two weeks at "Dome Rock," Platte cañon,

Colorado. This was a new locality, and Professor Snow treated it in his reports to the Academy as a separate expedition. The time was spent collecting insects. It was on this trip that a rock, twice as large as one's head, fell from a high crag and struck on a railroad rail and smashed itself to pieces, between the writer and Professor Snow, who were walking tandem only a few feet apart on the rail. (Kan. Ac. Sci.. vol. VI, p. 75.)

5. In 1879 Professor Snow made another trip to Colorado and camped for six weeks near Idaho Springs. He had his family and two student assistants, Miss Annie Mozley and L. L. Dyche, with him on that trip. This expedition secured, among other things, a fine collection of lepidopterous insects, especially catocala moths. (Kan Ac. Sci., Vol. VII, p. 61.)

6. In 1880 he conducted an expedition to Santa Fé cañon, New Mexico. Camp was located eight miles up the cañon from Santa Fé. The party was made up of the same individuals as in 1879. In four weeks' time 237 species and varieties of Coleoptera—many of them rare and some new to science—as well as many other insects, were secured. (Kan. Ac. Sci., vol. VII, p. 70.)

7. In 1881 Professor Snow conducted another expedition to New Mexico. The party was made up of Prof. H. H. S. Smith, of the department of physics, Doctor Snow's twelve-year-old son Willie, and L. L. Dyche. The party located its camp in the Magdalena mountains, twenty-five miles west of Socorro. After five days' collecting, a band of hostile Apaches passed near our camp and murdered a number of men who were driving freight-wagons over the very road we had traveled a few days before, between our camp and Socorro. The writer, who was out hunting deer that morning, heard the shooting off to the east in the direction of Socorro, but did not understand what it meant until later in the day, when the news was brought to our camp by a man who escaped from the wagons. He had a bullet-hole in the crown of his hat and had not discovered it until he reached our camp. After living in apprehension for our lives for three days, we returned to Socorro with a party of about a dozen miners and prospecters. Doctor Snow's party now spent about three weeks collecting in the neighborhood of Socorro, one day at Deming, and a week at the old city of Pecos, which concluded the expedition. (Kan. Ac. Sci., vol. VIII, p. 25.)

8. In 1882 nine weeks were spent near the Las Vegas Hot Springs, New Mexico. The party consisted of Professor Snow, his family, and three students of the University—W. W. Russ,

Miss Mary Dyche and L. L. Dyche. A general collection of insects and plants was made. (Kan. Ac. Sci., vol. VIII, p. 35.)

9. In 1883 he visited the same locality with his family and collected for two months in Gallinas cañon, near Las Vegas Hot Springs. His assistants were W. H. Brown, W. C. Stevens and L. L. Dyche, students of the University. (Kan. Ac. Sci., vol. IX, page 65.)

10. In 1884 he again visited New Mexico. This year the party was divided into two sections. Prof. Snow, W. C. Stevens, and his son, Willie, camped and collected on Walnut creek, near Silver City. The writer had charge of the second section of the party and was assisted by William Harvey Brown. We collected part of the summer at Harvey's ranch, on top of "Baldy" mountain, about twenty-five miles northwest of Las Vegas. We spent about six weeks of our time thirty to forty miles to the northwest of Harvey's ranch, on the head waters of the Pecos river. (Kan. Ac. Sci., vol. IX, p. 65.)

I find no report of expeditions made including the years from 1885 to 1903 in the proceedings of the Academy. During most of this time Doctor Snow was either experimenting with chinch bugs or was on duty as chancellor of the University and did not do much work on his collections. However he made trips during this period and did more or less collecting. He visited the following places:

11. In 1889, Estes Park, Colorado.
12. 1890, Bailey, Platte Cañon, Colorado.
13. 1891, Manitou Park, Colorado.
14. 1892, Estes Park, Colorado.
15. 1894, Magdalena mountains, New Mexico.
16. 1897, Estes Park, Colorado.
17. 1902, Hamilton and Morton counties, Kansas.
18. 1902, Oak Creek cañon and Humphrey's Peak, Arizona.
19. 1903, Clark county, Kansas.
20. 1903, Martinez or Congress Junction, and Williams Fork of Colorado river.

21. In 1904 Doctor Snow, with his regular assistant, Mr. E. F. Tucker, and Dr. C. F. Adams, spent three weeks at Galveston, Tex., making a general collection of insects. (Kan. Ac. Sci., vol. XX, part 1, p. 136.)

22. In 1904 he also visited Oak Creek cañon, Coconino county, Arizona, being assisted by Prof. W. H. Johnson and two students

—Eugene Smyth and Judah Drisco. (Kan. Ac. Sci., vol. XX, part I, p. 155.)

23. In 1905 Doctor Snow spent a month at Brownsville, Tex., and was assisted by Mr. Tucker and an undergraduate student, and Mr. E. G. Corwine. (Kan. Ac. Sci., vol. XX, part I, p. 136.)

24. Later in the summer of 1905, Doctor Snow and three student assistants, Messrs. Eugene Smyth, Ebb Crumb and Rollin Perkins, spent five weeks at San Bernardino ranch, on Sycamore creek, Cochise county, Arizona. (Kan. Ac. Sci., vol. XX, part I, p. 155.)

25. In 1906 Doctor Snow, assisted by L. A. Adams, a former student and assistant in the department of systematic zoölogy at the University, S. E. Crumb, and Eugene Smyth, spent June and July in Pima county, Arizona, making a general collection of insects.

26. In 1907 Dr. Snow made his last collecting trip to the Santa Rita mountains, Arizona. He was assisted on this expedition by W. J. Baumgartner, W. R. B. Robertson, and Fred Farragher, of the department of zoölogy at the University, and Eugene Smyth, of Topeka.

THE COLLECTIONS.

The fine insect collections, known now, by recent act of the board of regents of the University, as "The Francis Huntington Snow Entomological Collections," were built up largely from the material secured on these expeditions. Duplicate specimens were exchanged not only with the leading collecting entomologists of the United States but with a number of European collectors.

After returning from the various expeditions, Doctor Snow would work over the new material collected in his laboratory. Specimens of all species and varieties not found in his cabinets he would carefully pack in insect-proof boxes and send to specialists for determination. Though he secured several hundred species new to science on his various expeditions, I do not know of his having described and named a single species—finding the specimens and adding them to his fast-growing collections seemed to satisfy his mind.

As a result of his life's labor, he built up for the University of Kansas one of the largest entomological collections in the United States, and the largest in any educational institution, so far as we know, in the line of Coleoptera and Lepidoptera, except those at Harvard College. Some idea of the size of these collections may be obtained from the number of species, varieties and specimens it contains. An inventory has just been completed by Mr. Charles

H. Withington, who now has charge of the collections. The specimens in the regular museum collections are all named and set on insect pins with data labels attached. They are arranged in cabinet cases according to the best systematic classifications, so that it is possible for an entomologist to find any specimen in the collections almost as soon as it is called for.

	Number of species and varieties in regular named collections.	Number of specimens in regular named collections.
North American Coleoptera	8,089	35,052
" " Lepidoptera	3,736	12,208
" " Diptera*	2,244	6,741
" " Hymenoptera	1,304	3,912
" " Hemiptera	1,064	3,724
" " Orthoptera	492	1,845
" " Neuroptera	293	.....
Totals	17,222	63,482
Exotic Coleoptera	2,600	8,450
" Lepidoptera	981	1,716
Totals	3,581	10,166
Grand totals in collection, including exotics	20,803	73,648

*This includes the fine collection of flies donated to the University of Kansas by Dr. S. W. Williston, now of Chicago University.

As yet no careful inventory of the number of specimens in the duplicate collection has been made. However, it is safe to say that there are as many specimens in this duplicate list, ready for exchange, as in the regular permanent collections.

WILLIAM ASHBROOK KELLERMAN.

By J. T. WILLARD, Manhattan.

WILLIAM ASHBROOK KELLERMAN was born at Ashville, Ohio, May 1, 1850. He was graduated from Cornell University in 1874. In July, 1876, he was married to Stella V. Dennis, who, because of her bright mind and thorough interest in science, was companion and genuine helpmeet throughout the remainder of his life. He taught five years in the State Normal School, at Oshkosh, Wis., then spent two years studying in Europe, and received the degree of doctor of philosophy from the Polytechnic Institute at Zurich. Upon his return to the United States he was elected professor of botany in the State College of Kentucky, but later accepted a similar position in the Kansas State Agricultural College, where he remained seven years. In 1891 he became professor of botany in the Ohio State University, a position which he filled the remainder of his life.

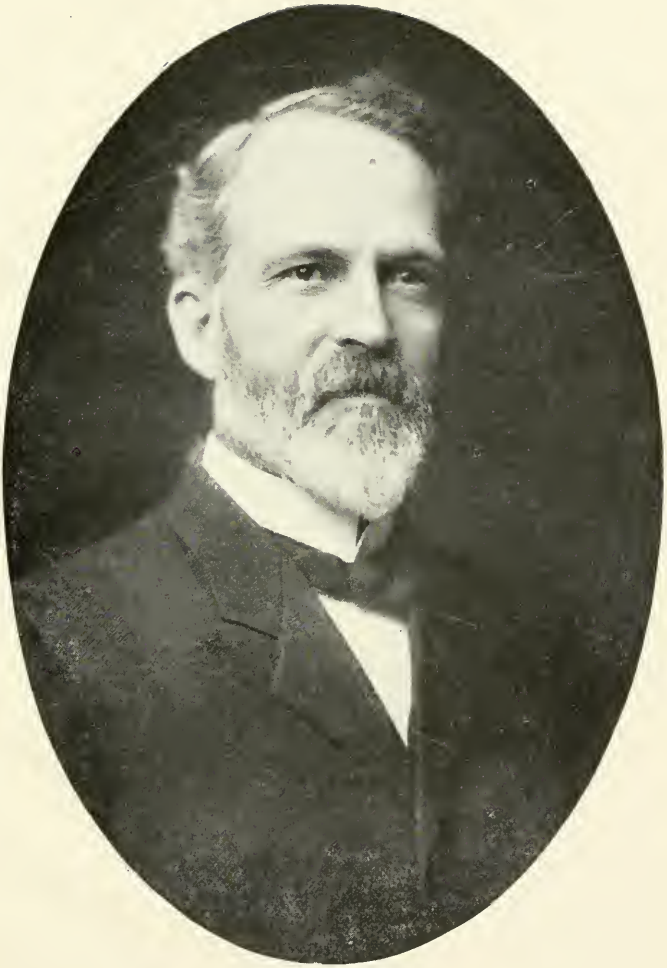
Doctor Kellerman was elected to membership in the Academy of Science soon after he entered the state, and, being in the very prime of life, was most active in his scientific labors. In fact, throughout his life he was an indefatigable worker and voluminous writer. A list of his publications appears in the Journal of Mycology for April, 1908, and fills nearly eleven pages. During his residence in Kansas he made several contributions to the Transactions of the Academy of Science, but these were but a small fraction, much appearing in the bulletins of the Agricultural Experiment Station, publications of the State Board of Agriculture, and various scientific journals. With Mrs. Kellerman he prepared an artificial key, "The Kansas Forest Trees Identified by Leaves and Fruit." The same authors also published "Analytical Flora of Kansas." In 1889 he published in the Academy Proceedings an "Artificial Key to the Kansas Grasses." Professor Kellerman's work at the Agricultural College was largely upon smuts and other fungi affecting farm crops. The results of these investigations were published in bulletins Nos. 5, 8, 12, 15, 21, 22 and 23. He also directed investigations on the results of crossing corn, which were published in bulletins Nos. 17 and 27. His work was not limited to what might be called purely scientific investigations, but included elaborate experiments touching the prevention of smut in oats and other cereals by chemical and other treatment. After his

return to Ohio his publications were, if anything, even more voluminous.

In January, 1885, he founded the Journal of Mycology, in collaboration with J. B. Ellis and E. M. Everhart. Doctor Kellerman initiated the enterprise and was responsible for it. After publishing it four years it was transferred to the United States Department of Agriculture and, later, discontinued; but in 1902 Doctor Kellerman revived it and carried the entire responsibility for the journal the remainder of his life. Doctor Kellerman was a specialist in mycology, and most of his contributions to science while a resident of this state referred to fungi in one way or another. He was the author of a text-book, "The Elements of Botany," 1883, and "Text-Book of Elementary Botany Including a Spring Flora," 1898.

In the later years of life he became greatly interested in the flora of Guatemala and made four trips to that country. He set out upon the last December 17, 1907, and had a very successful campaign collecting, and was nearly ready to return when he was seized by the fever that carried him off. He was buried at Zapaca in the country he loved.

Professor Kellerman had a most magnetic personality, and probably not one teacher in a hundred possesses the power to rouse the interest and enthusiasm of his students as he did. This was not by any artificial effort, but because of the overflowing of his own enthusiasm together with a rare gift of presentation. In his general scientific and philosophical views he was pronounced and in the ranks of the most advanced. He was fearless and outspoken in expressing and maintaining his views. In his character and ideals of conduct he was upon a plane that was impregnable to criticism. He was an inspiration to all with whom he came in contact, and his death was a loss to botanists the world over, and an irreparable one to his friends.



WILLIAM ASHBROOK KELLERMAN.

I.

PRESIDENT'S ADDRESS.

"THE LIFE HISTORY OF A RIVER."

By ERASMUS HAWORTH, University of Kansas, Lawrence.

THE LIFE HISTORY OF A RIVER.

By Erasmus Haworth, University of Kansas, Lawrence.

Presidential address, delivered before the Kansas Academy of Science, at Topeka, Kan., January 1, 1909.

DURING recent times much interest has been manifested in river floods and how to prevent damages from the same. This is particularly true in eastern Kansas and southwestern Missouri; a district with an annual rainfall of from forty to forty-five inches; a district with drainage streams which long ago reached the condition of grade or base level, and have since widened their channels to extraordinary widths with the usual meanderings by which the actual lengths of the channels have been increased many fold; a district subject to exceedingly irregular precipitation, and one therefore which is liable to have a period of floods at any time in the year or to have none at all. Elsewhere in America a like interest is manifested, partly due to increasing damages from floods as a necessary result of increase in population and improvements, but largely due to the general tendency of federal and state governments to look into matters of general public interest, and where deemed possible to give aid for a betterment of conditions.

This last aspect of the subject is modern—scarcely more than a decade old in most states—and, as a result, little has yet been accomplished beyond preliminary investigations and preliminary discussions of methods to be executed later. Practically all the states in the Mississippi valley have taken up the matter in one way or another, so that we now find measures enacted into law on the statute-books of the several states. Such statutes, although varying greatly in detail, are fairly uniform in one respect, namely, the creation by law of certain drainage districts with power to assess taxes on real estate for the purpose of making such improvements as each individual district may deem advisable. The federal government likewise has at least two departments—the Department of Agriculture and the United States Geological Survey—each of which is giving attention to the subject and for which limited appropriations have been made by the Congress of the United States. In each instance investigations of flood conditions are, in a measure, entwined with those of reclaiming swamp-lands and marshes.

Up to the present time the United States Geological Survey has done nothing in this line in Kansas. The Agricultural Depart-

ment, however, has made some preliminary surveys in the valley of the Neosho river, with a desire to ascertain what could be done to prevent such vast destruction of property by floods of that stream. Our neighboring state, Missouri, by proper legislation has legalized the drainage district idea, and in one notable case a comparatively large district has been organized and work is well under way whereby vast sums of money will be expended and a most interesting experiment undertaken. I refer to the work now in progress of straightening the channel of the Marias des Cygnes river in the southwestern part of Bates county, near Rich Hill.

Since the unusually high and destructive floods of 1903 different railroad companies have attempted to guard against further damage by building their grades excessively high across river vallies. This is notably true with the Santa Fé line across the Wakarusa valley south of Lawrence and across the Verdigris river valley just east of Independence, Kan. The present conditions in the Kansas river valley in the vicinity of Kansas City likewise should be mentioned in this connection. Where the various railroad lines cross and recross the valley in many different ways, apparently the management for each line has attempted to lift his grade as high as possible, with a hope of keeping the track above the water level in times of great floods. Years ago a similar attempt was made by the Missouri Pacific and other railroad companies whose lines cross the Marais des Cygnes river valley in the vicinity of Pleasanton and La Cygne, Kan., and eastward towards the Missouri state line.

At the present time there seems to be a prevailing idea that local, sometimes exceedingly local, improvements or precautions can be taken which, when properly executed, will protect a local area against flood damages regardless of what is done elsewhere in a given river valley. This is notably true along the Kansas river. Under the state law created by the state legislature called in extraordinary session in the summer of 1903, immediately after the destructive flood of that summer, drainage districts have been organized and much agitation has resulted regarding what to do and how to do it. There seems to be a general sentiment of widespread extent that all any local area need to do is to organize a drainage district according to law obtain the assistance of an engineer, and in a comparatively easy and simple way protect themselves against all future flood devastation.

It has seemed to the writer throughout this whole period of agitation that in most instances the proposed improvements for protection when executed may be almost futile and fall far short of

expectation. In some instances such improvements when made in a large measure will be directly in opposition to the great laws of nature which govern rivers. So few people apparently understand the foundation principles of rivers that, after all, mistakes of the kind above alluded to need not be surprising. It is desired, therefore, in the short time allotted to this paper to point out a few of the principles of nature governing rivers, to show the shortcomings of some of the schemes already adopted and of others proposed for adoption in various places, and possibly to make a few suggestions which may be of assistance to those engaged in this exceedingly important undertaking. The great fundamental laws of river erosion and river processes are plain and simple and easy to understand. Probably on account of their simplicity many people have failed to understand them or to believe in them when pointed out, insisting, as seems to be the part of human nature, that such processes must be more complicated and more mysterious.

It is only within the last half century, so far as I can learn from history, that any one has fully comprehended the principles governing the life history of a river. I need only refer to the well-known fact that when Captain Eads first proposed the improvements at the mouth of the Mississippi river, commonly known as "Eads' Jetties," it took him years to persuade our national legislators that such a scheme would accomplish the desired results, even if properly executed. It is an interesting fact of history that practically all the great engineers of our nation scoffed at the idea and insisted that his scheme was utterly impracticable, and, therefore, should not be attempted. And to-day I may say—and I do it in a spirit of humility and not one of criticism—and to-day I may say it is one of the greatest surprises to find how large a proportion of the practical engineers of our country have failed to grasp the fundamental principles of river action and put into execution improvements and precautions based upon them.

RIVER PROCESSES.

Every stream of water, no matter where situated on the surface of the earth, obeys the same fundamental laws that govern every other stream. It matters not where one goes to study this subject, data can be gathered in all parts of the world. Let us suppose that we are studying a stream in a mountainous district where the inclination of the surface is comparatively great, say at least 100 feet to the mile. During rainy weather the stream in question will have a fair amount of water and the tendency will be for it to cut its channel deeper. The cutting process is carried on in part

by the chemical action of the atmosphere, in part by the mechanical action of the flowing water. It matters not what the agencies are in detail, the point is that it cuts its channel deeper. This deepening of the channel will be continued until by and by a condition will be reached which prevents the deepening process being carried any further until general environments are changed. To give all the details substantiating this would require too great a time, but they are connected principally with the law governing the carrying power of flowing water. The carrying capacity of moving water varies as the sixth power of the velocity. Suppose, for instance, we have a stream with its water moving one mile an hour, and a second stream with its water moving two miles an hour. The carrying capacity of the water in the second stream will be sixty-four times as great as the water in the first stream. It is difficult for one to believe that this statement is true, and yet it is true both in theory and in practice, and has been incorporated in our standard text-books for twenty-five years or more.

Our stream under consideration during ordinary times will have but a small amount of water in it, and that will move at a slow pace, and will have but little carrying capacity. Its work in deepening the channel will consist principally in the dissolving power of the water. But when the heavy rains come and ten, twenty, and a hundred times the amount of water is poured into the channel the velocity of the moving water is greatly increased, and the carrying power correspondingly increased according to the ratio above named. The energy of this moving water will be devoted principally to cutting its channel deeper, until the water has all the load it can carry. In order to deepen its channel more, therefore, it must be given a greater velocity, or in some way it must get rid of some of its load.

Suppose now that at some place along the channel the velocity should be checked, never so little possibly. With a decrease in velocity the carrying power will be decreased sixty-four times as much. If the water was loaded to its limit a part of that load will be deposited the very instant a perceptible checking of the velocity is brought about. At that instant, therefore, the water ceases to cut its channel deeper and the reverse process is begun — that of filling up the channel. Usually the decrease in velocity is at or near the mouth of the stream, so that the filling up process begins at the mouth. It is common, therefore, to find a stream which is still cutting its channel deeper in its upper parts and the same stream filling up its channel in the lower part of its course.

If now we have a stream that rises in a mountainous district and flows across a plains area, and untimately enters the ocean, we have such a variety of surface inclinations that complications are set up. When the terrific rains come in the mountains the streams with high declivity assume the proportions of mountain torrents and the carrying power of the water becomes so enormously great that mud and silt and sand, gravel and boulders, all together are hurled downward as though they were mere toys. Few can appreciate the limit of such power. I have seen boulders, egg-shaped in proportion, more than twenty feet in diameter, weighing doubtless more than a hundred tons, which have been carried along by these mountain torrents; and as they went bumping the bottoms and the sides of the channel they produced wonderful execution. The same stream of water, however, cannot have this high velocity forever, and as the plains region is reached the angle of declivity is reduced, the velocity correspondingly is retarded, the carrying power is much more reduced and the unloading process is necessary. The first objects to be unloaded, of course, will be the largest ones. The force of the water against a boulder, or a gravel, or a grain of sand, is proportional to one-half the surface of the object, which, in turn, is proportional to the square of the diameter, while the weight is proportional to the volume, and that in turn proportional to the cube of the diameter. Therefore, the largest objects will be dropped first.

Visit a mountain stream whenever you may and you will find the boulders accumulating where the first check in the velocity of the current was brought about. If the decrease in velocity is sufficiently great, sand and mud will be intermingled with the boulders, but if the decrease is limited, then we find the boulders washed clean, the finer particles having been carried farther along. I need only revert to such streams as the Rio Grande, rising in the mountains above Albuquerque; the Arkansas, rising in the vicinity of Cripple Creek; the Potomac, rising on the summit of the Appalachians, or any one of the many other streams known to all. Where the angle in the surface is greatest there the most unloading occurs.

This unloading sometimes reaches enormous proportions, and the river builds up its channel until in extreme cases it is hundreds of feet above the plains on either side. Of course, such conditions cannot exist long, and sooner or later the water of the river will overflow its bounds and will get down onto the lower grounds on the right hand or the left, only to build up another channel. In

this way a stream from a high mountainous area crossing a wide plain may have migrated over hundreds of miles laterally. Excellent examples of this may be observed at the present time in streams reaching the Pacific coast from the Coast Range mountains. It is universally true that the streams in the steeper parts are still cutting their channels deeper, while on the plains between the mountains and the ocean they are building up their channels with debris brought from above, and are shifting from place to place as above mentioned. The question, therefore, of whether or not a stream will cut its channel deeper or will fill up the channel and elevate itself to positions actually farther from the center of the earth than those previously occupied is dependent entirely upon the somewhat intricate and delicate balancing of velocities and loads.

FLOOD-PLAINS.

The building-up process at the bottom of the river channel and the widening of the bluff lines soon produce an almost level valley area known as the flood-plain. In times of high water a river covers the entire flood-plain and a variable amount of sand and silt and mud are deposited, thereby building up the general level of the valley. Some streams have built up their flood-plains for more than 100 feet, as shown by the depth of the flood-plain material. In general, the depth is greater near the mouth of a stream, but irregularities of surface produce great irregularities in the thickness of the flood-plain material throughout a flood-plain area. The materials usually are laid down in broad, horizontal layers well stratified, but sometimes local irregularities occur where washouts, sink-holes, etc., are made in the flood-plain material during times of high water.

It should be noted that the very presence of a river flood-plain is evidence that the river has covered the entire flood-plain area. Earth movements often change such conditions, allowing a stream to begin cutting its channel anew after it has built up a former flood-plain. Such cases are rare in the Mississippi valley, however, and in eastern Kansas none have been found. The highest ground existing in any of the eastern Kansas river valley flood-plains was created by flood waters from the stream and remain to-day a silent witness to the fact of great floods having overflowed the entire flood-plain area, no matter what the stream may be.

We may say, therefore, in discussing any particular part of a stream, that in its early stages, in its youthfulness, it is deepening its channel, but when the period of maturity has been reached it

is no longer capable of cutting its channel deeper. Water continues flowing through it, however, and a process of meandering is as absolutely necessary as it is that the stream exist. This meandering of the channel is a most important point, particularly in connection with all river improvements. As cutting continues under this new set of conditions, the so-called ox-bow curves are formed, such as can be seen along the course of any stream.

Let us suppose that we could straighten the channel of a stream throughout a distance of a hundred miles, building an entirely new channel. Would this new channel remain straight for any considerable length of time? It certainly would not unless extra precautions were used. If the water be encased in walls of masonry, the channel would remain straight as long as the masonry walls remained intact. If a less pretentious protection were given and the walls were riprapped, using the term in the ordinary way, meandering processes would be hindered, but sooner or later the tendency would become so great that the riprapping would be worn away in places, after which its existence elsewhere would only assist and intensify meandering processes. This same fact may be stated in another way. Any channel of a river may be kept in its present position by a sufficient interference on the part of man so long as this interference is maintained. If the people in a given community wished to retain a river channel in its present position for a thousand years, they could do so by a sufficiently strenuous effort in the way of preventing the stream from cutting its banks. The converse of this is also true. A stream which has already ceased cutting its channel deeper may be made to shift its channel at the will of man, provided sufficient influence is brought to bear upon it, the energy of the running water being used entirely for the execution.

When a stream has reached a certain degree of meandering or of crookedness, the same stream has a tendency to straighten its own channel. This tendency is manifested principally in two ways, one by cutting its banks during mild floods until the necks of the ox-bow curves are destroyed; the other by excessive floods when the water spreads from bluff to bluff and the current, ignoring the ordinary channel, flows in an approximately straight line between the bluffs. This new current often cuts a new channel deep enough to hold the current after the flood has subsided. A river, therefore, makes crooked its own channel, apparently in order to have the privilege of straightening it, but in reality when working under the inflexible laws of nature.

APPLICATION.

To apply the general principles already enumerated and to bring about by a variety of coercion a set of conditions which will in a measure decrease the extent of floods, and thereby lessen the destruction of life and property in the river valleys during flood periods, is the end sought by all investigations and all improvements undertaken, as outlined earlier in this paper. The end sought by different parties is the same, and there should be a unanimity and coöperation in our efforts.

Floods are caused primarily by excessive and irregular rainfall, a statement so simple that few people realize its importance. Were our annual precipitation uniform week by week and month by month the river channels now on the face of the earth probably are abundantly large to carry all the precipitation back to the ocean without overflowing the banks of a single stream. But rainfall is most irregular, and combinations of this irregularity are almost infinitely variable. Could our heavy rains come all at once over the entire drainage area of a stream so that they would produce the maximum effect our floods would be many times more disastrous than they are. For example, throughout the Mississippi valley, it is by no means unusual for as much as four inches of rain to fall within a period of forty-eight hours and in many places a rain of two or three inches sometimes falls within a period of one hour. Who can calculate the results should we have a precipitation of four inches throughout the entire Mississippi river drainage area within the same period of forty-eight hours? The floods would so far exceed anything that has ever been known by man that we can hardly conceive of the disaster which would follow. But, fortunately for mankind, the rainfalls are irregular, and during the short period of the white man's inhabitance of the Mississippi valley no instance has been known when all of the great tributaries of the Mississippi river were at their highest flood at the same time.

Instead of four inches of rain, sometimes we have six, or eight, or ten, or even more, over small areas within a very short time. One extreme case came under my observation during the past summer. A relatively small area in northeastern Kansas lying north of the Kansas river and principally east of the Blue river received a total precipitation of forty-five inches within a period of five months, nearly all of which came within two months, and in some instances from four to six inches came within as many hours. The little town of Frankfort, in Marshall county, is situated on a small stream, less than two miles from its source, and the thought of danger from

floods apparently never occurred to its citizens when the town was first located. But during the early summer of 1908 one of those terrific rainstorms came which covered the whole surface with from four to six inches of water and the little stream was utterly incapable of carrying water away as fast as it should have done. As a result, the streets of Frankfort were flooded, parts of the village which presumably were on high ground were inundated, and even a passing freight-train carrying live stock was stranded and the live stock drowned while the cars were standing on the track.

It is a combination of such extreme cases of rainfall that produces our floods. If they have occurred in the past they may occur in the future, and no matter what the improvement may be, or how many drainage districts with corporate power may be called into existence, now and then as time progresses these unfavorable combinations will occur and flood conditions will exist far beyond the control of man. So long as we are unable to control the rainfall and compel it to come somewhat at our pleasure just that long floods will come, river valleys will be covered with water, property will be destroyed and human lives lost. Unfortunately, science has not yet discovered the fundamental principles of meteorology. No basic principles are known upon which may rest long-range predictions of rainfall. We do not know whether next year will be wet or dry, and if wet, whether excessively so. We cannot foretell whether the heavy rains will come all at once over wide areas, causing the most disastrous floods of history, or very irregularly, so that but slight damage will be done. One thing is sure, namely, wherever a river flood-plain now exists it has been covered with water from that stream. If so in the past, why not in the future, and why not have a greater combination of heavy rains than ever before and a greater flood than ever before? So long as we remain in such gross ignorance concerning the profound laws of meteorology just that long will we be in like ignorance regarding the probabilities of unfavorable combinations which produce destructive floods.

It seems most improbable that climatic conditions have changed to any considerable degree in recent times, or that they will change within the next thousand years sufficiently to have much influence on floods; and even should they change, the new conditions are just as liable to be worse as to be better. It is the duty of the scientist, therefore, to look at matters just as they are. From this standpoint it seems practically certain that occasionally excessive floods will come which will be so great that any and all the works

of man will be powerless in the prevention of great disaster. Such an agent of destruction should be looked upon in a measure as we look upon earthquakes and tornadoes and volcanoes — nature's great processes for modifying and beautifying the surface of the earth — and man should avoid their disastrous results principally by keeping out of their way. It should not be considered a mark of the highest degree of intelligence deliberately to put one's self directly in the pathway of such a manifestation of nature's forces.

The above general statements refer to major or excessive floods. A great many minor floods occur which are less destructive in their action, and which, in a measure, certainly may be modified and made less severe. Three different lines of improvements or methods have been suggested, commonly called the reservoir method, the levee method, and the channel-straightening method. These may be considered separately.

RESERVOIRS.

Flood prevention by the reservoir method is believed in by those who consider it feasible to build many reservoirs throughout the drainage area of a stream so that a portion of the rainfall water may be caught in the reservoir and doled out leisurely to the streams under the control of man. It is argued that it is the last portions of the rainfall added to rivers which cause the floods, and that therefore such portions as may be held in the reservoirs will in a degree keep the "last portions" from entering the stream and thereby prevent the flood. But the facts are that such reservoirs are filled with the first part of the rainfall and not with the last part, and the water caught in them, if let alone, would be the first to enter the streams, and probably would be well out of the way down-stream before the last came. Could we build reservoirs with draw-gates so that we might let the first storm water run through them and then close the gates and hold the last rainfall they would undoubtedly be of service.

In the arid and semiarid districts, where the rainfall is under twenty inches per annum, some of the most severe local rain-storms occur. The ground is usually dry and hard and parched, and the rain-storms are so excessive that a large proportion of the total rainfall runs off the surface and down into the streams, causing excessive local floods. In such regions reservoirs would be most serviceable, because they could be built so as to hold a larger fraction of the rainfall, and in a degree would compensate for the excessive rapidity of precipitation. In a climate such as is general throughout the Mississippi valley, however, it is doubtful about

the reservoir system exerting a very appreciable effect. The tendency, however, would be in the right direction and we should combine all methods which have the proper tendency, in order that in the end we may have the greatest influence.

FORESTS.

During recent years much has been said regarding the influence which deforesting and reforesting an area may have upon floods. The great champion in the cause of cultivating forests to prevent damage by floods is the honorable Government Forester. His enthusiasm has become contagious, and advocates of reforesting treeless areas as a means of flood prevention are numerous in all parts of the United States. The subject is discussed here because in a way it corresponds to the reservoir system.

Rain falling upon a forested area is partially consumed in wetting the leaves and branches of the trees, and to a perceptible degree the water is held back and enters the drainage channel more slowly, which in turn prevents a sudden rise of the stream. For ordinary rains and mild floods there can be no doubt but that such a covering of forest-trees materially reduces the stage of high water. But here, as with reservoirs, it is the first rain that falls which wets the leaves and branches and trunks of the trees. When excessive rains come, four and five and six inches, the early rains thoroughly wet and saturate all parts of the forest-trees—trunk, branch and leaf—so that the latter part of the rain will have about the same influence on flood conditions as though the forests were not there. It seems to the writer the importance of quantitative influence of forests has been greatly exaggerated. Enthusiasts even go so far as to claim that could we have our entire country reforested the whole problem of flood preventions would be solved. Such parties should not be called scientists, because the scientist sees in the river flood-plains, as already explained, positive evidence that the river valleys of America have been visited by floods in times past fully as much and probably more than in modern times. This geological evidence is not old simply because it is geological. It deals with the most recent period of geologic time, and links the past with the present. It is little short of folly to teach that destructive floods can be prevented by reforesting the surface of the country, no matter to what extent such reforesting may be carried.

In a measure, forests in a river flood-plain become positively objectionable because they retard the flow of water already in the stream. No sooner does a stream overflow its banks than the forest-trees interfere with the flow of water here, just the same as

they do on the uplands. Anything whatever which retards to any degree the flow of water after it once enters a stream becomes directly a flood producer. There can be no question but that when the water has once overrun the flood-plains every tree, every bush, every blade of grass retards its movements. To whatever extent this is done they are positively objectionable. It is passing strange that so much importance should be placed on this subject at a time so little removed from the days when practically all of the river valleys in America were forested, in view of the fact that all of our history and legends coincide with geological evidence showing conclusively that our rivers overflowed their banks in those days as frequently and to as great an extent as they do now.

LEVEES.

Certain prominent citizens and engineers are enthusiastic over the beneficial effects that may be obtained by the building of levees along river banks in order to prevent flood destruction. It seem to the writer that this method of improvement in general should be handled with great care. In effect, it is virtually the the same as deepening the channel. All rivers while meandering through their flood-plains naturally build levees. Invariably such streams through the greater part of their course have built up the levees from five to ten feet and even twenty feet above the flood-plain farther back from the river. At Lawrence during the flood of 1903 there was one little spot of dry ground on the north side of the river immediately at the river bank. Between this and the bluff to the north in some places the water was as much as ten feet deep, while here the surface was from one to three feet above the water level, showing that the natural river levee was ten or twelve feet higher than the main flood-plain farther towards the bluffs. But with all this natural levee building streams overflow their banks and change their channels. The influence of artificial levees is similar to that of the natural levee. They are first-class for mild floods, but when excessive floods come they must be entirely inadequate, and after the flood-waters break through them they become positively harmful, in that they interfere seriously with the free flow of the water.

One phase of this subject apparently has been overlooked, and it is the most important one, namely, the filling up of the bed of the stream, which in itself is immensely objectionable. Could the Kansas river be leveed five feet in height from Junction City to its mouth, it is practically certain that such a process would increase the tendency of the stream to silt up from the bottom.

As the water in a stream increases in depth there is an increasing variation in the velocity of the water at top and at the bottom. The water near the surface cuts the banks and supplies itself with silt in accordance with its carrying capacity determined by its velocity. A stream twenty feet deep has a larger absolute amount of water near the bottom flowing slowly than the same stream would have when but five feet deep. The silt gathered from near the top gradually works downward and on account of the slow-moving water below silts up the bottom of the river much faster than would be done if the stream were only half as deep. The filling done by one flood simply helps the stream to overflow its banks the more readily during subsequent floods, and therefore becomes a menace.

As just stated, levees undoubtedly are serviceable and satisfactory for mild floods. It is surprising, however, how many engineers, some of them government engineers, overlook the fact that levees must be inordinately high in order to accommodate all the water of great floods. Suppose we should try to levee the Kansas river to hold it within its banks during a flood equal to the one of 1903. At Lawrence the water was more than five miles in width with an average depth of about five feet. The cross-section area, therefore, of the flood-water was so great that levees would have to be built more than ten times as high as is usually mentioned in order to provide a channel which would contain all the water. According to newspaper accounts one of the leading engineering firms of Kansas City made surveys up the Kansas river beyond Lawrence and made a report to a citizens' committee, who employed them, which report in turn was sent to a government engineer. According to these same newspaper accounts both the Kansas City engineers and the government engineer advised building levees to a height only a little greater than that to which the water rose, mind you, on the supposition that it would protect the valley lands from flood-water in the future, omitting entirely to take into consideration the vast amount of water spread out over the valley. They are said to have estimated that such a system of levees could be built for about $14,000 per mile on each side of the river. It cannot be believed that engineers of the reputation of the ones referred to ever would subscribe to such a fallacious doctrine. The influence on the public mind, however, has been wrought and the unscientific landowner situated in the river valley is likely to believe that the newspaper accounts are correct, and that therefore such a system of levees should be built.

It should be noted here also that the tendency of the stream to

meander its channel would be just as effective in times of flood with the flood currents working against the levees as though they were working against a natural bank. The soft materials of the freshly made levees would melt away under such influences with surprising rapidity, and in order that such levees be maintained practically it would become necessary to keep a strong force of men at work along the entire distance leveed throughout each period of high water.

Somewhat similar to levee building is a process of raising the grades of railroads recently indulged in to such an extent in many places along river valleys. If a railroad grade is parallel with the stream, raising the grade will be beneficial to the road. If, however, it is transverse to the direction of the water current, it serves as a dam and only makes a bad matter worse. It is beyond my ability to understand the actions of some railroad engineers in this respect. Here and there we find railroad grades virtually forming dams from bluff to bluff across streams with only a few small openings through which the water can flow. A notable recent example of this is along the Santa Fé railway across the Wakarusa valley south of Lawrence. Since the flood of 1903 this grade was raised from two to five feet. It is almost directly across the river valley. In 1908, I am reliably informed by parties who actually made the measurements, this performed the function of a dam to such an extent that the water was from eighteen to twenty inches higher on the up-stream side than on the lower side. A large amount of money was spent in this movement, only to find that it impeded the flow of the water to such an extent that the last condition, if possible, is worse than the first. What would have happened had the same grade been built five, ten, twenty or a hundred feet higher, provided it was strong enough to withhold the force of the water pressure? It seems plain that it simply would have created a great reservoir on the up-stream side and that ultimately the water-level would have reached the top of the grade just the same as it did before the last improvements. The great mistake was made by not providing suitable outlets for the water to get away.

The engineers evidently thought they did, forgetting apparently that the entire valley in 1903 was necessary for the current. It seems almost madness to assume that in times of a like flood a runway one-tenth or one-twentieth the width of the valley was sufficient to let the water pass.

In a similar manner other river valleys in many places have these great railroad grades crossing them, serving as immense dikes to

impede the current. Almost invariably the openings through them are so few and so entirely inadequate that they cause the water in the river valley to rise much higher than it otherwise would, and therefore such grades become one of the great flood producers.

CHANNEL STRAIGHTENING.

Advocates of channel straightening have many points of fact with them. The fundamental principle underlying this method is the hurrying away of water already in a channel so that it may not be present when the last of the flood-waters arrive. Anything whatever which impedes the water current in a stream tends to produce a flood. In its qualitative influence it becomes a flood producer, because it holds back water already in the channel until new rainfall water may overtake it. Conversely, any influence which will hurry water along and get it out of the way tends to prevent a flood, and therefore should be applied wherever feasible. The universal tendency of streams with flood-plains is to silt up their channels, as already pointed out. This filling in process is greatly increased by driftwood, stumps and other objects becoming lodged, which retard the velocity of the water in the bottom of the stream. Clearing a river channel of stumps and trees and snags, therefore, in a measure increases the velocity of the water. One can hardly believe that intelligent landowners would spend vast sums of money in river improvements to prevent floods and at the same time neglect to provide against such river obstructions. But we find these contradictory actions in many parts of America.

Suppose a drop of rain falling at Junction City occupies four days in traveling to Kansas City, and suppose again that by removing impediments in its pathway its velocity could be increased so that it would make its journey in three days. Certainly at any given point throughout its course it would be out of the way much earlier than should no improvements be made, and, therefore, its influence as a flood producer would be correspondingly lessened. If now we find a stream which has carried its meanderings to such an extent that the length of its course has been doubled, the length of time required for water to travel the course likewise would be doubled, yes, more than doubled, because its actual velocity would be in a measure retarded. Throughout the course of every stream with a flood-plain meandering is more pronounced in some places than in others, and in such places a maximum good could be accomplished by straightening the channel.

In the southeast corner of Bates county, Missouri, the Marais des Cygnes river has excessive windings throughout a stretch of

about twenty-five miles. Under provisions of a state law a drainage district was incorporated and all the land within it taxed to defray the expenses of straightening the channel. A skilled engineer was employed and improvements are now well under way. By building a new channel twenty-three and a half miles in length the present channel, seventy-three miles long, will be abandoned. It is estimated that it now requires water three and a half days to travel this seventy-three miles, while but eight hours will be required to travel the twenty-three and a half miles. This shortening of time is much greater than shortening of distance, because, with no curves to encounter, the water will meet with less friction. Again, the twenty-three and a half miles will have the same absolute fall as the seventy-three miles, changing the fall per mile from eight inches to about twenty-six inches, which of itself would almost double the velocity of the water.

Suppose now we have a flood-time in the upper Marais des Cygnes river and that a given stage of flood is reached at the upper part of the straight channel. Within eight hours this water will have traversed the twenty-three and a half miles and be entirely out of the way of succeeding portions of the flood, while under previous conditions it would require three and one-half days to pass the lower point of the new channel, and therefore more than two-thirds of the early flood-water would be retained and added to the later flood-water. Certainly such an improvement will have a very strong tendency in the right direction. Could the Marais des Cygnes river have its channel straightened from the vicinity of Quenemo, in eastern Osage county, Kansas, to its mouth, below Jefferson City, it seems probable that the floods would be greatly reduced.

One of the phases of this subject that should be emphasized is the possibility of using the waste energy of the water current to help in cutting new channels. There is no more necessity of using man power and steam power to do all the work than there is for using like power to turn the turbine wheels at a water-power plant. An engineer who fully understands river principles can devise means for applying the current energy.

DAMS.

Since the flood of 1903 much agitation regarding flood causes and flood preventions in one way and another has been connected with dams across streams. Here again it seems to the writer facts are not understood.

The influence of a dam across a stream during a mild flood cer-

tainly is in the direction of causing the river to break over its banks up stream from the dam. This influence, however, is not so entirely an unmitigated evil as is an ordinary obstruction in a river channel. A tree or bridge pier or snag checks the velocity of water and in no degree works a recompense for it, so that its influence is entirely bad. A dam across a water stream checks the velocity of water, but in turn necessarily in a measure compensates for it by causing the water to flow with greater velocity as it passes the dam. Observations and measurements universally show that when water begins rising in a stream it rises faster below the dam than it does above, so that when a stream becomes sufficiently high the presence of the dam cannot be told from the appearance of the surface of the water.

Let us suppose that we have a dam five feet high. At low stages of water the water-level above the dam will be five feet above the water-level below. As a flood approaches this difference in level begins diminishing—first to four and one-half, then four feet, then three and one-half, etc. A little thought will show why this is so. Let us assume that we have a rise of ten feet above the dam, so that a volume of water ten feet in depth will flow over the dam. Now, every one knows that the water at and near the surface flows very much faster than water near the bottom of the stream. The farther the surface is removed, therefore, from the top of the dam as the flood rises the less influence the dam will have on this rapidly flowing water, which constitutes the main run-off of the stream. During low stages the dam, therefore, produces its maximum effect, which effect is gradually decreasing in percentage proportion as the water rises.

In confirmation of the above theoretical consideration it should be added that a careful investigation of the Kansas river valley immediately after the flood of 1903 failed to reveal any material difference in damages produced along the river valley above and below the dam at Lawrence. I had eight assistants working under me examining the river valley from its mouth westward to Junction City. These were young men not one of whom was a citizen of Douglas county. One of the charges I gave them was to look carefully into this question and determine if possible whether or not the dam at Lawrence produced any appreciable effect in the volume of damage done by the flood below the dam and above the dam. The unanimous statement was that, so far as they could determine by careful observations, flood damages were just as great below as above.

In times of mild floods, however, dams certainly do produce bad effects. They cause the water first to break over the river banks above the dam, which in turn is liable to set up new channels, and to flood certain areas which otherwise would not be disturbed.

SPILLWAYS.

It has been suggested that where dams are built spillways should be provided around an end of the dam so that during mild floods an excessive amount of water could flow past the dam without overflowing the banks above. This, under certain circumstances, would be a move in the right direction. Its value would be made *nil*, however, provided the channel of the stream below the dam was not sufficiently wide to carry away the water as fast as it passed over the dam and spillway combined. The production of a spillway beyond this point would be an unnecessary waste of money. This question of dams and spillways is here introduced because again the public press, from time to time since the flood of 1903, has been agitating the subject, and great dissatisfaction and unrest have been worked up with the masses of people living in the river valleys in eastern Kansas and other parts of America. According to press reports a government engineer recently has passed up and down the Kansas river valley and its tributaries, counting the dams across the various streams, and giving utterance to statements in effect that such dams must be removed, after which damage from flood will be a thing of the past. I wish to call attention to the well-known fact, as before stated, that these same streams overflowed their valleys practically to as great an extent before such dams were built as they do now. We have abundant historic evidence of this covering the past fifty years, and we have positive geologic evidence of this written in the flood-plains of the streams, as already explained. It should be remembered, therefore, that such dams may produce bad influences during mild floods, but that these bad influences decrease as the floods increase in volume, so that when the flood reaches the proportions of those of 1903 practically the dams' influences are almost *nil*.

All too often it happens that attempts at river improvements are made in the wrong direction. For a sad example of this, I need only refer to actions of citizens at Pine Bluff, Ark., in their attempt to protect property from river destruction during the flood of the Arkansas river only a few weeks ago. Here is a town situated on the convex side of a bold ox-bow curve in the river. At flood-time the current was constantly striking against the bank so as to increase the crookedness of the channel. Opposite this part, along the con-

cave side of the curve, where the current already was so weak it was depositing parts of its load, a citizen's committee began cutting down the bank and throwing the dirt into the water in an attempt to entice the strong current away from the opposite bank. What they did in reality was to add to nature's methods by which the river was first made crooked, and, therefore, so far as they had any influence on the stream they made it wear away with increased energy the very bank they hoped to protect.

A most important consideration which should be made prominent is the futility of attempting great river improvements in restricted areas with a hope of accomplishing much good therefrom. A stream large enough to do great damage must necessarily drain a sufficiently large area to make mere local improvements of but little value. We must expand our conceptions of the magnitude of nature's processes and modify our efforts accordingly. For a stream as big as the Kansas river, or Missouri river, with a flood-plain from three to five miles wide, what a great disappointment awaits those who now have faith in mere local improvements. There should be a coöperation of all interested parties for a distance of at least a hundred miles up and down the valley, and two hundred miles would be much better. Great floods are not mere local affairs, and little can be expected from mere local treatment.

On the other hand, river improvements are immensely expensive. No class of citizens is justified in spending vast sums of money to save property unless reasonable returns are to a degree insured. While the American Indians roamed over our vast prairies and held a valuation on land of less than one cent an acre, no such land would bear taxation sufficient even for building respectable fords across the streams, much less for building bridges, while as for improvements to guard against flood devastation it was entirely unthinkable. But when a great city is built and land becomes worth a thousand dollars a front foot, it would almost stand taxation to encase the stream in polished marble.

In general land values in America are now intermediate between the two extremes just named. The time has come when we should begin to make improvements, but values in general are yet too low to admit of very great ones. The intelligent thing to do, therefore, is to begin work in the right direction, strictly in accord with the laws of nature, and on sufficiently broad lines so that ultimately our accomplishments will be commensurate with our efforts. We should harness the water currents and compel them to turn their great surplus energies into our hands for us to direct their expen-

ditures in a manner that will accomplish the desired ends. If the energy of a water current builds great crooks and curves in a channel when allowed to run wild, then the same energy may be made to straighten the same channel if properly applied. If a stream is capable of doing sufficient work to transport vast amounts of material necessary to build up its flood-plain scores of feet in thickness and miles in width, then the same stream may be made to keep its own channel free and clear of obstructions just as soon as the mind of man becomes capable of directing the work. We are not here dealing with the changeable whims of an individual, but with the immutable and unchangeable laws of inanimate matter. Let us all hope that in the near future our minds may be opened up to a full comprehension of such laws and how to apply them to our good, and that our hearts may be expanded so that we may all work in perfect harmony in accomplishing these great ends.

II.

CHEMICAL AND PHYSICAL PAPERS.

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   By Adolph Ziefle, University of Kansas, Lawrence.
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   By J. T. Lovewell, Ph. D., Topeka.
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6. "Some Fluctuations in the Mineral Contents of the Kaw River."
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9. "The Lactose-bile Test for the Colon Bacillus."
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THE IMPORTANCE OF PHYSIOLOGICAL ASSAY IN THE STANDARDIZATION OF SOME DRUGS.

By Adolph Ziefle, University of Kansas, Lawrence.

THE main factors which have been responsible for the increasing interest and change of attitude shown in problems connected with the use of drugs in the treatment of disease, and especially in their standardization, are mainly these: The first was the appearance of the new Pharmacopœia, causing as it did many discussions in regard to the admission of new remedies and a change in the standard of some of the older preparations. The second was the establishing of the Council on Pharmacy and Chemistry, which exposed false claims of many "quack" remedies by showing that they were entirely without value as remedies for the ailments for which they were so highly recommended. This council also investigated the condition of many official preparations, and showed that many of them were far from being up to standard. The third factor, and by far the most important, was the establishing of drug laboratories for the state and national pure food and drugs law. These laboratories have submitted to them for analysis every known form of remedies for the treatment of disease. Very frequently chemists are unable to give conclusive information about certain remedies because of the lack of the necessary equipment for physiological examinations.

The uniformity in strength of any drug is one of the first essentials. Its preparation shall also possess physiological qualities to a uniform degree—in other words, should be of a uniform standard.

The recent Pharmacopœia has made greater advances in standardization than any previous one, in that it requires in many more instances than formerly that the drug shall be standardized so as to contain a certain fixed percentage of its active principle, thus assuring the physician a more definite and reliable preparation.

Probably the foremost cause of the variation of standards is the fact that the drugs often vary notoriously in content of active principle. This variation depends upon climatic conditions, different localities, the time of year when drug is collected, and, probably of greatest importance, upon the manner in which the drug is prepared for market and the way it is preserved before it is used. This, then, accounts for the varying degree of physiological activity

of preparations made exactly in the same percentage of crude drugs, but using drugs from different sources.

No insistence is needed on the desirability of a uniform standard of activity for all drugs, and especially such as contain especially highly active principles of highly toxic nature. In the case of some, such as cinchona, hydrastis, opium or nux vomica, such a standardization is easily carried out by chemical means. These drugs owe their activity to the presence of certain specific alkaloids which are of such a basic nature that they unite readily with acids, thus affording a means of assay. These particular alkaloids are also sufficiently stable that they can withstand the action of strong acids, alkalies, and quite a high heat, and can be determined gravimetrically.

There are, however, other drugs in which the active principle is of such a nature that attempts at chemical investigation, if not misleading, are unsatisfactory, even though the active principles are recognized and something is known of their chemical nature. Typical instances of such drugs are digitalis, strophanthus, squills, ergot, cannabis indica, aconite, and others. The active principles of the first three, called the "cardiac group," are of a glucosidal nature, and as yet there have been no good chemical methods given by which these principles can be isolated quantitatively. However, a very good and simple physiological method has been in use for years and is used by all well-equipped manufacturing houses at the present time. Until very recently it was not known that ergot contained its active principle in the form of an alkaloid, and heretofore it has been analyzed physiologically by its effect upon the rooster's comb. Although the alkaloidal ergotoxin exists in ergot, it is present in such very small quantities that it would be difficult to isolate it quantitatively.

Cannabis indica, a notoriously variable drug, is highly active, but unfortunately its chemistry has not been sufficiently investigated, so that there is a consensus of opinion among authorities as to what its active principle is. However, the drug can be thoroughly standardized by observing the nervous symptoms produced by a given dose in a dog or cat.

Physicians and pharmacists alike have recognized the necessity of some way of standardizing these preparations, and have introduced physiological methods of assay which are being used by all of the larger manufacturing houses, and it is mainly due to these that methods are being perfected.

That these drugs and their preparations vary has been proven by the foremost pharmacologists.

Dixon, in the *British Medical Journal*, says that he and Haynes demonstrated in Cambridge the variability of action of the group of cardiac tonics, including digitalis, strophanthus and squills. He makes the statement that he believes hundreds of patients die annually from digitalis and its allies in not possessing the exact quantity of active principle required of them.

Houghton states, in the *Journal* of the Medical Association, that he found by testing preparations of the well-known active drug strophanthus that some were three times as strong as others.

A series of investigations by Edmunds on tincture of digitalis is very interesting, and shows very plainly the uncertainty of this particular preparation. His object in collecting the samples was to get the greatest variety in respect to different methods of manufacture, drugs from different sources, and tinctures made from supposedly assayed fluid extracts from certain manufacturing houses. His results showed that some of the tinctures are almost four times as strong as others, or, in other words, that four or five drops of one will produce the same effect as fifteen of another preparation. Since the average dose of tincture of aconite is ten drops, it can be plainly seen what a marked variation in activity there would exist if these were dispensed. Another interesting feature shown by this investigation was that a pharmacist made two preparations, one being four times stronger than the other. Four samples for the same wholesale house varied very markedly, but this was not strange, since they made no pretense at physiological assay.

These instances I have mentioned are by no means rare. They exist in every drug and its preparations for which there is no chemical method of assay, and it is merely a question of "luck" with the patient when he gets his prescription, and unless very rapid advances are made to perfect and simplify methods for physiological assay for these questionable drugs this dangerous condition will become worse instead of better.

I trust that you will not infer from the above that I am pessimistic in regard to this precarious condition of certain official preparations on the market. During a period of nearly two years we have come in contact with nearly all druggists of this state by analyzing one or more of their own prepared official preparations. The condition in which we found some of the more simple ones leaves no room for doubt that they would make a decided failure in the attempt to manufacture these more difficult preparations. At

present our drug laboratory is amply equipped for chemical investigation, but the very necessary equipment for physiological assay is still wanting. Until we do have this installed we are helpless to give conclusive information in regard to the relative values of the drugs I have mentioned, and many others.

THE MANUFACTURE OF ENAMELED WARE.

By R. D. LANDRUM, University of Kansas, Lawrence.

THE manufacture of enameled-steel cooking utensils is an industry which could and should be carried on in Kansas. Her natural resources (especially her minerals and abundant supply of fuel), her industries allied to enamel making, and her central location, are all points in favor of Kansas as compared with other states for the location of enameling works.

An enamel is a vitreous silicate resembling glass or porcelain, but which forms an intimate coating on the surface of a metal. On a vessel which is to be used for cooking the enamel must not be brittle and must have a coefficient of expansion near that of the metal. It must resist both acids and alkalies and must contain no lead or other poisonous materials.

The following materials are used in the making of enamel for cooking utensils: Flint, quartz and glass-sand supply the silica, feldspar and clay the alumina. Fluorspar and cryolite are added on account of their fluorin content and assist in making the enamel opaque, thus giving it "body." Soda-ash and pearl-ash are fluxes, and borax, which acts as a flux also, keeps the enamel from being brittle and brings out the color from the metallic oxids used as pigments. Saltpeter and Chili saltpeter act as decolorizers, as well as being fluxes; and magnesium sulfate and ammonium carbonate, which are added to thicken the wet enamel, are among the raw materials, as well as carbon, chromium oxid, cobalt oxid, copper oxid, uranium oxid, selenium and gold oxid, and especially tin oxid, antimony oxid and zinc oxid, which are pigments giving color to the enamel.

Enameling is still held as a secret art, and the formulas are carefully guarded. In the company with which I was chemist for three years very few visitors are allowed to go through the works, and none of these are taken through the laboratory or the room in which the enamels are mixed. Each of the raw materials used has a number, and they are always designated as such. They are shipped so that the bill of lading contains only the number. All

boxes, barrels and bags have these numbers on them, and they are stored in bins under their numbers.

Employees of one department are never allowed in another, and after a man has worked in one department he is barred from all others. Then, too, some of the enamels are made up of several different frits, melted at different times, and mixed by different men.

In the making of an enamel the various raw materials are loaded from their respective bins into small cars called "dollies." These are filled to a line which approximates the correct weight, then they are pulled on a scale, the beam of which is hidden from the workman, and the chemist in charge indicates whether the load is light or heavy, and the workmen correct this by shoveling on more or taking some off. When each of the "dollies" is corrected so that the required amount of material for a mix is in it, all are dumped on a large hard maple floor, the coarser material on the bottom and the finer on the top. This pile is thoroughly mixed by shoveling, and is loaded into an electric elevator which hoists it to its bin. There is a bin for each different kind of an enamel, and a traveling bucket which holds a melt (about 1200 pounds) carries the mixing to the crucible furnaces where it is melted into a liquid glass.

These crucible furnaces are regenerative reverberatory furnaces like those used in the manufacture of glass, and our natural gas or crude oil would be an ideal fuel for them. However, in the older enameling works coal is used, and in the later ones, mainly in the coal-fields, producer-gas is used as a fuel. The temperature required for the different enamels runs from 1000° C. for a glaze to 1300° C. for a ground coat, and the temperatures are measured by a pyrometer, using a Herans platinum iridium thermo-couple. Natural gas or crude oil as fuel would make the attaining and regulation of these temperatures an easy matter. Each furnace will give seven or eight melts a day, and is in charge of a head melter. After the enamel is melted into a liquid glass a fire-clay plug in the front of the furnace is pulled out and the molten enamel is allowed to flow into a large tank of cold water. The contact with this causes it to quench into very small particles. The water is drained from the tanks and the "enamel frit" is left. This is shoveled into pans (a certain weight to a pan) and is ready for grinding.

In the mill-room the enamel frit is ground in large ball mills for about thirty hours. These mills are cylindrical, about eight feet long and five feet in diameter, and are lined with porcelain bricks. The frit is put into them with an equal amount of water and several

per cent. of white imported clay. For the white cover enamels tin oxid is also put in at this time. The enamel is ground until it will pass through a hundred-mesh sieve, by large round flint stones which are put in with the mixture. The enamel, on being taken from the mill, has about the consistency of rich cream. This is loaded into tanks, where it is allowed to age a week or so.

From the mill-room the enamel is taken to the dipping-room, where it is put into tanks that are like large dish-pans. These are sunk into tables, and at each tank a "dipping girl" works. The dipping girl takes the stamped-out steel vessel, which has been thoroughly cleaned, and plunges it into the enamel. When taken out the wet enamel forms a thin film all over it. By a gentle swinging motion the excess of enamel is thrown off, and the vessel is placed bottom down on three metal points projecting from a board. Three or four vessels are put on a board and then carried to the drying-room, a room which is between the dipping- and furnace-rooms.

The furnace-room contains a long bank of muffle-furnaces, each one of which has a muffle about twelve feet by six. In these the ware is put after drying. The temperature in these furnaces is about 1100° C., and here the little powdered particles of enamel are fused together in a solid glass covering over the vessel. About five minutes' time is required for each load put into the furnace. Five men and boys attended each furnace—the head burner and two assistants, two carrier boys, and a beading boy. The beading boy takes up a little black enamel (an enamel made as above described) on his finger and puts it around the top of the vessel before it is burned. This makes the black bead around the top of the vessel.

Each coat is burned separately. For instance, we have a tea-kettle that is to be a three coat—white inside, turquois-blue mottle outside. The vessel is first dipped in the ground coat enamel, the excess of enamel is shaken off, it is put on a three-pointed rack, and dried in the drying-room. After drying the enamel stands in little grains all over the surface of the ware, adhering to the metal on account of the raw clay ground in with it. At this stage every care must be taken, for a scraping even of the finger nail would take off some of the powdered particles of the enamel. This kettle is then put into the muffle of the furnace, and the heat fuses all the little particles together and we have a tight-holding vitreous coating all over the surface of the vessel. This coating is nearly black, due to the oxids of cobalt, nickel and copper which it contains, and shines

with a glass-like luster. The vessel is cooled the ordinary temperature of the furnace-room.

The vessel is again brought to the dipping-room, and here it is dipped into an enamel—this time a white enamel. This goes through the same process as before, except that the beading boy puts a black bead around the upper rim. On account of the dark color of the first coat showing through, this second coat, after it is burned, has a gray appearance, and is called the "gray coat." The vessel is again sent to the dipping-room, and here it is dipped into white enamel, the excess shaken off, and the blue-green enamel is sprayed on the outside.

This spraying process was at one time done by dipping a wire brush into the wet blue-green enamel and the "dipper-girl" shaking it over the surface of the vessel, causing the blue enamel to fall in little speckles all over the white enamel. Lately spraying machines have been put in, which work on the principle of an atomizer. A tank full of the colored enamel stands over the table and the enamel is forced out through a nozzle in a spray by compressed air. The flowing of the enamel is controlled by the foot of the dipper-girl as she holds the vessel to be sprayed in the enamel spray. The vessel is now dried and the coating fused in the muffle-furnace, the result being turqoise-blue spots on a white background. After a handle and lid are put on in the assembling department the vessel is sent to the assorting room. Here all ware is divided into three lots—first, second and job lots. Some of the second and job lots are fit for redipping. They may have some little spots where the original vessel was not properly cleaned and where, on account of this rust or dirt, the enamel did not stick. These spots are filed or are held under a sand-blast until the surface is perfectly clean, and the vessel is dipped with another coat.

There are schemes for saving money in all manufacturing plants, and in the enameling business a large part of the profit comes from the residues. For instance, every bit of enamel is scraped from the tanks and tables; all sweepings from floors are saved, and all the waste water from the various departments is first carried into catch-basins, and every few days these are cleaned and the residue which has settled to the bottom is taken out. The residues from all these sources are again melted with the proper amount of fluxing material and coloring matter, and this dark-colored enamel is used for coating the cheaper ware.

Among other things to be considered in the enameling business is the kind of steel used to make the vessels that are to be enam-

eled. It must be as nearly as possible pure iron, and must be especially low in carbon and sulfur, as these ingredients give off gases upon heating. The following is the analysis of a steel which gave very good satisfaction:

Sulfur	0.045	per cent.
Phosphorus	0.032	"
Silicon	0.010	"
Manganese	0 080	"
Carbon	0.105	"

The grain must be as open as possible, and this fact bars the use of steel which has been cold rolled.

The necessity of having a perfectly clean surface to enamel makes the process of cleaning or "pickling" the ware before enameling very important. In the first place, a lubricant must be used in stamping that is easily removed. For this a sort of soap is used. Then the ware is "pickled"; first in an alkali solution to remove the grease, and then in an acid solution to remove the rust. It is washed between and after these processes in hot water, and after a thorough drying is ready to be enameled.

The foregoing is a brief description of the process of enameling, and the question now comes up, "Is Kansas peculiarly adapted as a place to locate an enameling works?" Our location is geographically the center of the United States and our railroad facilities are excellent. We have near at hand the principal raw materials needed, viz.: Flint, quartz, sand, feldspar and clay; salt and limestone for the manufacture of soda-ash; magnesium sulfate, zinc oxid, and bone-ash, and borax nearer to us than any other enameling plant I know of. The materials for pickling—hydrochloric and sulfuric acids and sodium carbonate—are already being manufactured in the state. However, leaving these all aside, our natural gas and crude pretroleum are so abundant and so ideally adapted both for the production of power and for the melting of the enamel and the burning of the ware that they alone would make it profitable to manufacture enameled ware in Kansas.

ECONOMY OF HEAT IN COOKING.

By J. T. Lovewell, Ph. D., Topeka.

IT is well known that the potential energy of fuel, when applied to steam-engines, is largely dissipated without mechanical or other useful effect. It is none the less true when applied to cooking that heat goes out into the flues or produces uncomfortable temperatures in our kitchens, while but a small percentage of it is actually employed in those preparations of food we term cooking.

In most of these operations the essential thing is the maintenance of requisite temperature long enough to secure those chemical changes and that breaking up of starchy or proteid constituents which renders the food palatable and easy to digest. In the great majority of culinary processes there is no necessity for evaporation with the consequent loss of heat, nor for the access of air. As ordinarily conducted there is often a great amount of vapor set free, mixed with other gases with unpleasant odors. Then there is the discomfort of having this vapor condense on windows and furniture and contaminate the air we must breathe. To avoid this waste of heat and its unpleasant results, we have only to raise our cooking vessels and their contents to the proper temperature and then put them into an enclosure where the heat cannot escape. It is the continuance of heat and not its constant addition which effects the cooking.

Our problem is to prevent the escape of heat; and while the solution is not absolute, we can secure practical results without much difficulty. Of the modes of heat transference, radiation, convection and conduction, we shall need to consider chiefly the latter in making an enclosure impervious to heat. Metals, well known as the best conductors, will therefore be discarded from our list of available materials. Of other solids, various kinds of wood, stone and manufactured products remain to be chosen from, and their merit is chiefly determined by the amount of air-spaces they include. The poorest conductors are liquids and gases, but the former are obviously not available, and we are therefore led to choose a substance filled with air-spaces so small that convection need not be considered, and have practically a gaseous enclosure for retaining heat.

We may take wood where the air-cells are formed in the natural growth of plants, or we may take asbestos or many other silicates

of earthy elements, which are either formed among the rocks as long fibrous filaments, or may be manufactured by processes analogous to that employed in making gas-mantles. We may employ sawdust. cork cuttings, also the fibers of plants, as cotton, hemp, etc., or may use animal products, as wool, fur, felt, and feathers; but in all these the efficacy will be determined by their porous qualities, *i. e.*, by the included air-spaces. An enclosure that has much to recommend it both as a non-conductor and as an antiseptic is charcoal. The makers of refrigerators have found this out, and often surround the ice-chest with a stratum of charcoal.

When cooking is confined to substances that require only the boiling temperature of water, the plan of the ordinary fireless cooker is sufficient, and will secure most satisfactory results; but if it is desired to give a scorching temperature, as in the baking of bread and pies or in the roasting of meats, it will be necessary to raise the cooking inclosure to the required degree of heat either by hot bricks, slabs of steatite or by a gas jet. An electric heater would perhaps be the best means of any to get the oven hot, and then the source of heat may be turned off, and the oven closed and left to finish the cooking process more evenly and with less danger of burning than in the old way. The fuel saved here is the whole amount needed to run the furnace during the period of baking. The old brick oven was like this in principle, but it took a large amount of fuel to heat such a mass of brickwork, for there was no device to prevent radiation and waste of heat, and therefore a great supply must be stored up.

There is a field for inventive genius in the construction of a stove which shall be surrounded by non-conducting material, so that when any desired temperature is reached the fire may be turned off and the viands receive requisite cooking without further application of heat. The non-conducting envelope for such an oven, when it is to be adapted to all kinds of cooking, must be of some non-combustible material which has the essential closed air-spaces, and the mineral asbestos will at once be suggested as both cheap and effective. When the boiling temperature is high enough, as is the case with most kinds of food, then the restriction of our envelope to non-combustibles is not necessary, and we have the simple requirements of the ordinary fireless cooker. Starting with the boiling temperature, such an oven, properly made, will not lose more than twenty-five degrees in five hours, leaving it amply hot to cook cereals. When evaporation is necessary, then, of course, this economy of heat is not possible, for evaporatian implies a con-

stant escape of heat. It is fortunate that the majority of viands do not require the evaporating process.

It should be remembered that fireless cookers must be kept clean. Vapors are given off and will condense more or less on the walls, packing and lining, and these ought to be removable and adapted to ready cleansing. This renovation need not be very frequent, certainly no more often than is required in a refrigerator, which employs the same sort of barrier to keep heat out that is needed by the cooker to keep it in. The germs of putrefaction and decay are destroyed more readily by the high temperature of our cooker than by the ice-cold temperature of our refrigerator.

In either utensil precautions are needed. The plea for economy of heat in cooking will apply equally well to economy of ice in using an ice-cream freezer. In most such freezers no care of this is taken. The low temperature is secured by liquefaction of ice and salt. The heat required for the solution is secured from the surrounding vessels and their contents, which are thereby frozen. There is seldom any care taken to surround the freezer by a non-conductor, and therefore the heat required for melting the ice and and salt is taken quite as much from the surrounding air as from the cream. So more ice is used than needed, and the laborious turning of the freezer is superfluous.

A simple fireless cooker makes a pretty good freezer. First have a vessel sufficient to contain the material to be frozen, then a larger vessel into which the former will sit with a space of one and one-half or two inches between the two, and this space is to be packed with pounded ice and salt. Then put this combination into the proper compartment of a fireless cooker and shut it up. The cream will be frozen in a little longer time perhaps than the revolving freezer requires, but with half the expenditure of ice and salt, and without further care or labor. When so frozen it will keep there all day and longer without melting.

DISCUSSION OF A PELTON WATER-WHEEL TEST MADE AT THE UNIVERSITY OF WISCONSIN.

By CHAS. I. CORP, University of Kansas, Lawrence.

THIS discussion is the result of a series of tests made at the University of Wisconsin in the summer of 1908. The work was a continuance of an investigation by Prof. D. W. Mead to find, if possible, an algebraic equation between the head, horse-power and revolutions of a water-wheel.

He shows in his book on Water Power Engineering some relations between discharge, head, velocity-ratio, etc., which hold for the low-head experiments on which he bases his conclusions.

It is the purpose of this paper to show that, for the Pelton wheel at least, these relations hold for higher heads, and also to work out the equation spoken of above for the wheel used.

RELATION OF HEAD AND DISCHARGE.

We know in the case of the nozzle of a Pelton wheel—

(1) $$q = ca\sqrt{2gh}$$

where q = discharge in cubic feet per second.
c = coefficient of discharge.
a = area of the nozzle.
g = force of gravity.
h = head in feet on the nozzle.

If the buckets of the wheel are sufficiently removed from the nozzle not to affect its discharge and the coefficient of the nozzle is a constant, the discharge will vary as the square root of the head. Figure (1) shows this relation nicely. The experimental points were first plotted, using the square root of the heads as the vertical ordinates and discharges as the horizontal ordinates. If the relation sought holds true these points will lie on a straight line through the origin. This is shown to be the case. The points for the curve between the heads and discharges were taken from this straight line. The points indicated by circles along this latter curve are experimental points.

RELATION OF RATIO (ϕ) AND EFFICIENCY.

Theoretically, the velocity of the buckets of the Pelton wheel should be one-half the theoretical or spouting velocity of the water to work most efficiently. Actually, due to eddies and friction of

the water in the bucket, and to the fact that the reversed stream of water must clear the next bucket, this ratio is something less than one-half.

It is evident efficiency will fall off as we either increase or decrease the value of the ratio of bucket velocity to spouting velocity from this most efficient value.

In figure (2) the values of the ratio of bucket velocity to theoretical or spouting velocity (called Φ) have been plotted horizontally and the efficiencies vertically for every increase of 10 feet in head between 20 and 157.7 feet. A single line averaging the heads above 60 feet has been drawn. It will be noticed the points for any one head may fall both above and below this line, so that for the practical working limits of the wheel the efficiency varies as the ratio (Φ).

RELATION OF HORSE-POWER AND HEAD.

The theoretical horse-power of a wheel $= \frac{wh}{550} = \frac{qh}{8.8}$, where (w) = weight of discharge in pounds per second.

(3) The actual or brake horse-power $= P = \frac{qhE}{8.8}$, where (E) = efficiency.

Combining (1) and (3):

$$P = \frac{ca\sqrt{2g}\ h^{3/2} E}{8.8}, \tag{4}$$

It is apparent if c and E are constants, and if Φ remains constant, the power of the wheel will be in direct proportion to the three-halves power of the head, or—

$$\frac{P}{h^{3/2}} = \frac{P_1}{h_1{}^{3/2}}. \tag{5}$$

This reduces to—

$$P = \frac{P_1\ h^{3/2}}{h_1{}^{3/2}}. \tag{6}$$

In figure (3) brake horse-power has been plotted vertically and velocity ratio (Φ) horizontally for each of the heads considered in figure (2). The maximum horse-power for each head occurs at practically the same value of Φ ($= 0.45$).

The values of brake horse-power for each head, when $\Phi = 0.45$, was used to plot the curves of figure (4). In figure (4) a straight line was first obtained by using the three-halves powers of the heads and brake horse-powers as coördinates; the curve between head and brake horse-power being drawn from this line, and the experimental points then put in. This curve shows the brake horse-power will vary as the three-halves power of the head when Φ is a constant.

In equation (6), if we make $h_1 = 1$—

(7) $$P = P_1 h^{3/2} \text{ where } P_1 = B.\ H.\ P. \text{ under one-foot head.}$$

That is, the horse-power that can be developed at any head will equal the power at one-foot head multiplied by $h^{3/2}$.

RELATION OF REVOLUTIONS AND HEAD.

The bucket velocity of a wheel is—

(8) $$v^1 = \frac{\pi D N}{12 \times 60},$$

where N = Revolutions of wheel per minute.
D = Diameter of wheel in inches.

Also spouting velocity is equal to—

(9) $$v = \sqrt{2gh}.$$

Combining (8) and (9):

(10) $$\frac{}{v} = \frac{\pi D N}{720 \times 8.025 \sqrt{h}} = \Phi.$$

As equation (10) is general, it follows that when Φ is constant—

(11) $$\frac{D N}{\sqrt{h}} = 1841.6\ \phi = \text{a constant.}$$

"The catalogue speed, power and discharge of each series of wheels, as given in the catalogues of the manufacturers, are usually based on the conditions of maximum efficiency and constant Φ.

"From the above considerations it follows that in any homogeneous series of wheels, that is, in any series of wheels constructed on uniform lines and with dimensions proportional, the wheels of the series are designed to run at the same relative velocity, and therefore—

(12) $$\frac{D\ N}{\sqrt{h}} = \frac{D_1\ N_1}{\sqrt{h_1}}.$$

"That is to say: In any homogeneous series of turbines" (true, also, of the Pelton wheel) "the product of the diameter of any wheel (D), and the number of revolutions (N), divided by $\sqrt{h}$, will be a constant, provided Φ remains constant.

"If, in equation (12) $D = D_1$, the equation reduces to—

(13) $$\frac{N}{\sqrt{h}} = \frac{N_1}{\sqrt{h_1}}.$$

"That is to say: The economical speed of any wheel will be in direct proportion to the square root of the head under which it acts.

"If in equation (13) $h = 1$, the equation reduces to—

(14) $$N = N_1 \sqrt{h}.$$

"From which it follows that the revolutions of a wheel (N) for

any head (h) is equal to the revolutions (N_1) for one-foot head multiplied by $\sqrt{h}$."*

This relation might also have been shown by means of curves from the test at hand.

EQUATION BETWEEN HORSE-POWER, REVOLUTIONS AND HEAD.

(15) $$\text{Brake horse-power} = P = \frac{2\pi rLN}{33{,}000}.$$

where r = Length of brake-arm in feet.
L = Load on the brake in pounds.

We have shown that under the usual assumed conditions of maximum efficiency and constant Φ, $N_1 = N_1 \sqrt{h}$ and $P = P_1 h^{3/2}$, so that equation (15) may be written in the form—

(16) $$\frac{P}{h^{3/2}} = \frac{2\pi rL}{33{,}000h} \times \frac{N}{\sqrt{h}}.$$

For simplicity let $\frac{2\pi rL}{33{,}000h} = \frac{CL}{h}$, where $C = \frac{2\pi r}{33{,}000}$ = a constant, and $\frac{N}{\sqrt{h}} = n$ = revolutions per minute under one-foot head.

Plotting the values of $\frac{CL}{h}$ as the vertical ordinates and of (n) for the horizontal ordinates for the various heads previously considered, figure (6) will result. In this as in figure (2) the points for heads above 60 feet fall along a general line, which has been drawn in.

The product of the horizontal and vertical ordinates of any point on this curve will be the brake horse-power of the wheel under one-foot head and having the revolutions indicated by its horizontal ordinate.

The general algebraic formula connecting two variables such as $\frac{CL}{h}$ and (n) is—

(17) $$\frac{CL}{h} = a + bn + cn^2 +, \textit{etc.},$$

where a, b, c, etc., are constants.

It was found that an equation having three terms on the right side of the equality sign gave a curve which corresponded sufficiently close to the experimental curve for practical purposes.

The constants a, b and c were obtained by choosing three points on the experimental curve and substituting the values of their coordinates in the general equation above. The resulting three simultaneous equations were solved, giving as the equation of the curve:

(18) $$\frac{CL}{h} = .000106 - .0000009376n - .00000000266n^2.$$

* "Water Power Engineering," by Mead.

Whence, multiplying both sides by (n):

$$\frac{CLN}{h^{3/2}}=\frac{P}{h^{3/2}}=.000106n-.0000009376n^2-.00000000266n^3. \tag{19}$$

If we now multiply both sides by $h^{3/2}$ we have—

$$\begin{aligned} P&=h^{3/2}(.000106n-.0000009376n^2-.00000000266n^3). \\ &=h(.000106N-0000009376N^2-.00000000266N^3). \end{aligned} \tag{20}$$

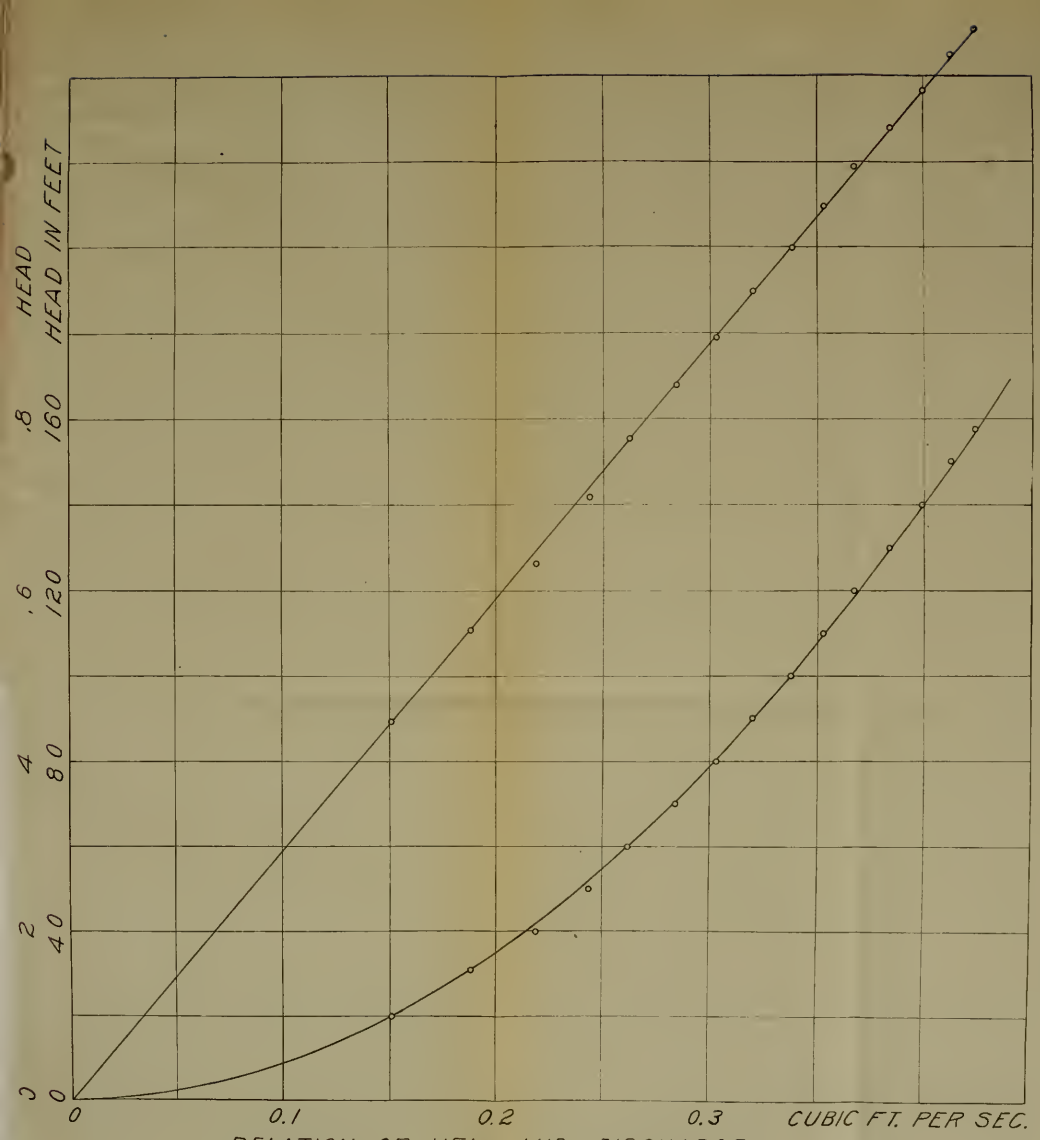
An equation which will apply directly to the wheel tested and to wheels built on the same lines and with dimensions proportional. The same form of equation can be worked out for different makes of wheels.

PRELIMINARY REPORT ON AN INVESTIGATION OF COAL-MINE EXPLOSIONS.

By E. Haworth and C. M. Young, University of Kansas, Lawrence.

THE investigation of the causes of coal-mine explosions, of which this is a preliminary report, was commenced in 1906 by the Kansas State Geological Survey. In that year Lawrence Brett, one of the seniors at the University of Kansas, took this as the subject for his graduation thesis, and did a considerable amount of work, with the expectation of continuing the work later. Lack of funds has prevented the accomplishment of anything further until the present year. In the spring of 1908 Prof. Erasmus Haworth, state geologist, decided to devote the larger part of the funds at the disposal of the Survey to a continuation of this investigation. This paper is to be considered as only a preliminary report, as the investigations discussed are not completed and others are to be undertaken. But we desire to make known some of the results which have been accomplished and to make a statement of plans for the future.

The work has been divided into two distinct classes; the first literary, the second experimental. Along the first line, what might be called a literary bureau has been established and an extensive correspondence carried on with many people connected with the coal-mining industry both in this country and in Europe. A list of questions dealing with the subject was sent to a large number of coal-mine operators. Many replies have been received and the results have been tabulated. These questions were intended to elicit all possible information on the conditions of the coal-mining industry in the different coal-fields of the United States, with the idea of learning what conditions may render possible the occur-



RELATION OF HEAD AND DISCHARGE.

FIG. 1.

of coal-mine operators. [illegible]
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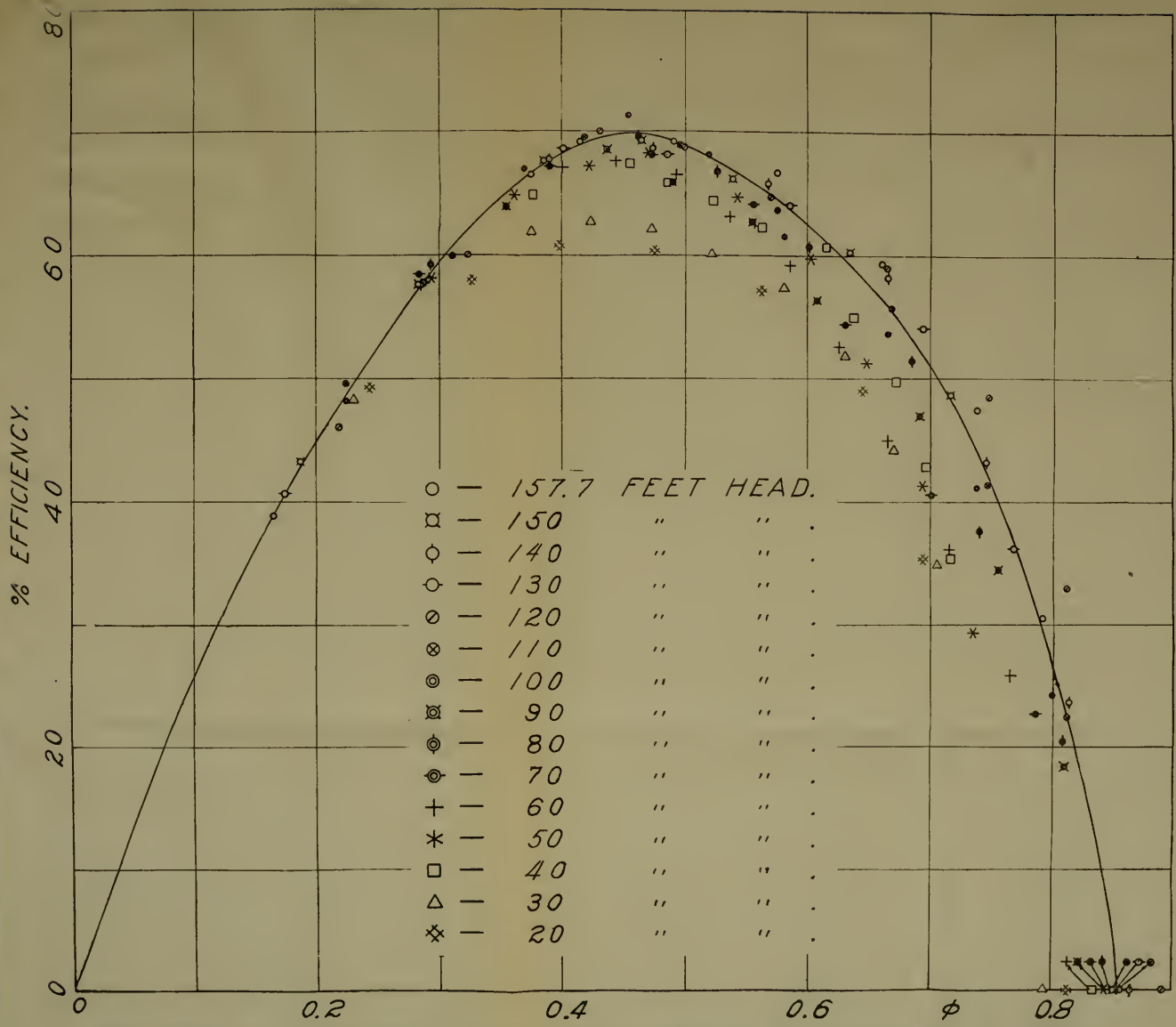

RELATION OF EFFICIENCY TO RATIO OF PERIPHERAL VELOCITY TO $\sqrt{2gh}$.

FIG. 2.

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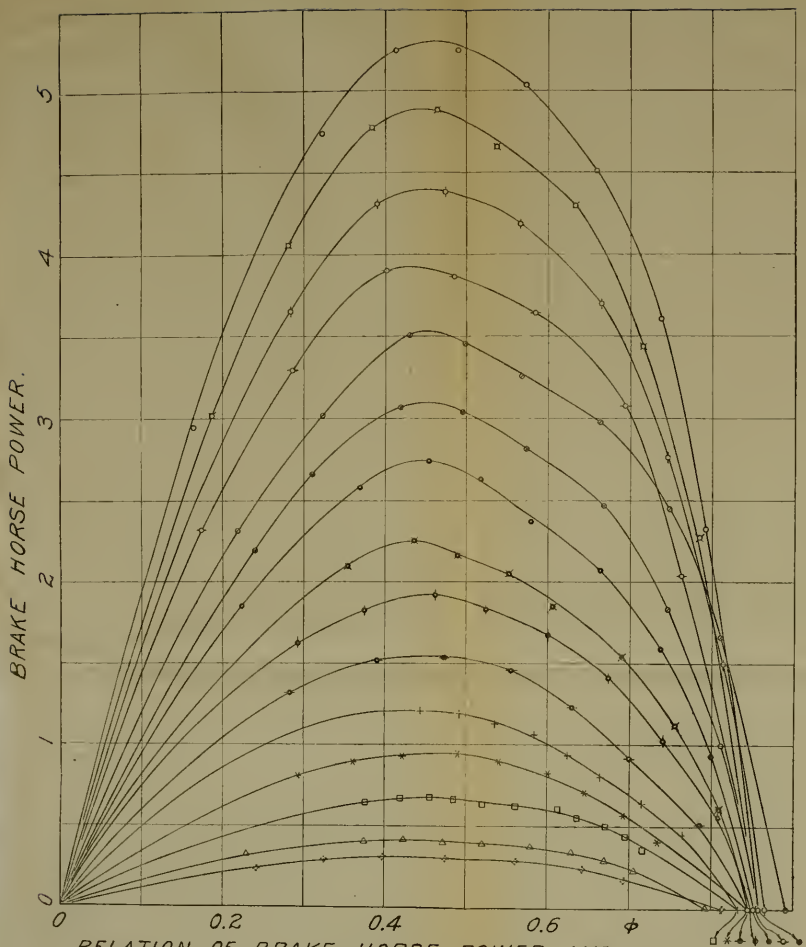

RELATION OF BRAKE HORSE POWER AND RATIO OF PERIPHERAL VELOCITY TO $\sqrt{2gh}$

FIG.-3.

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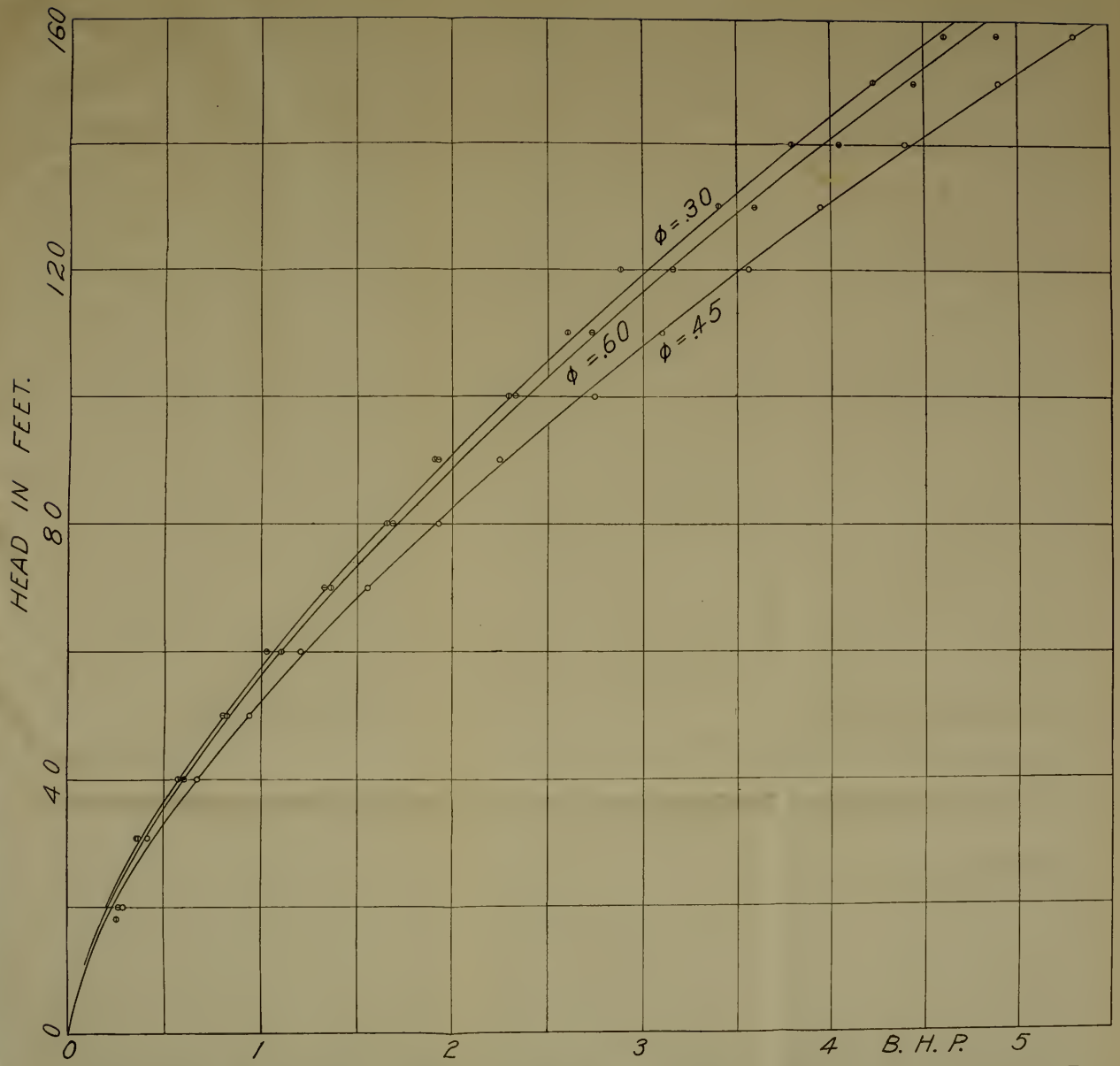
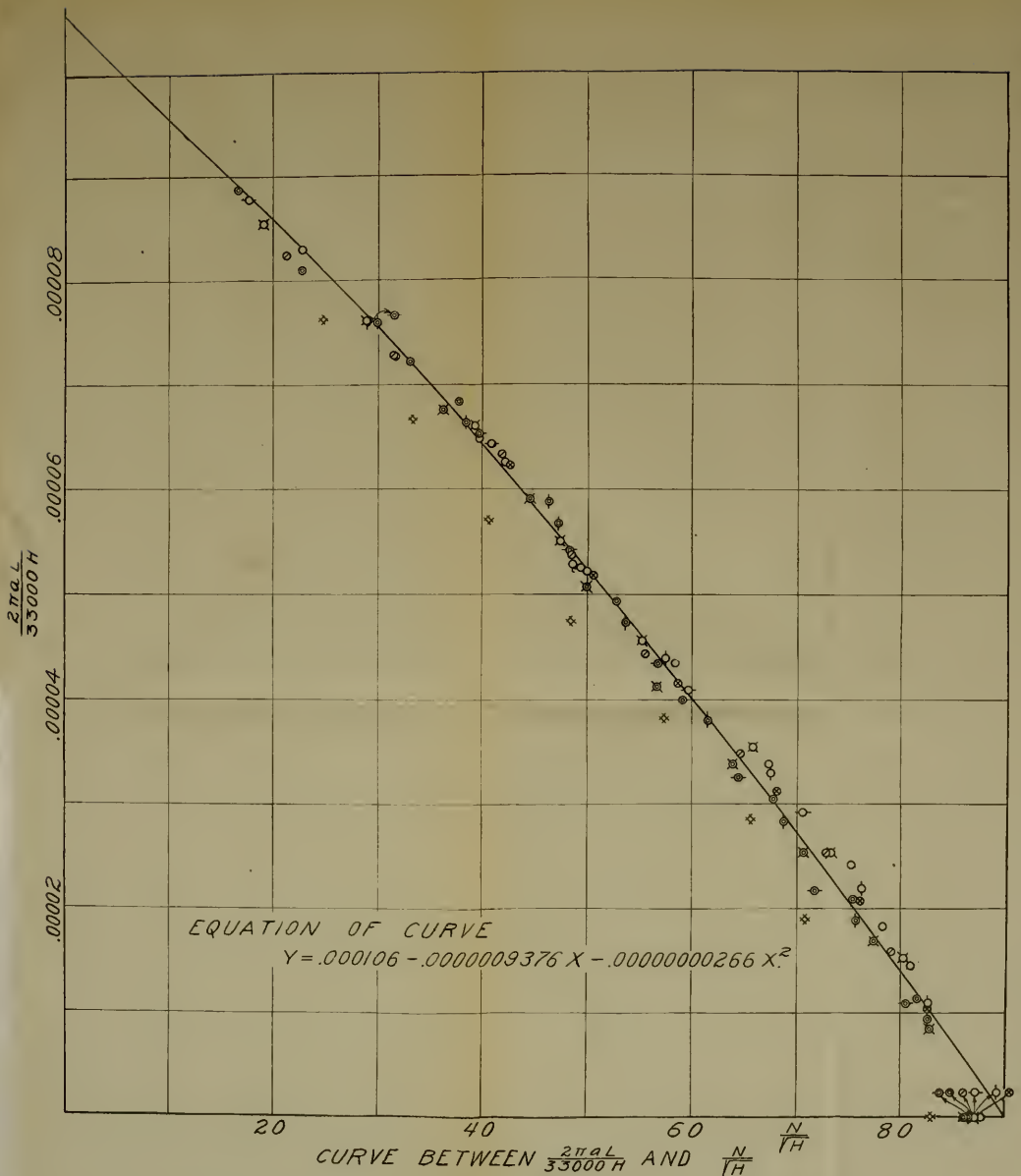


RELATION OF BRAKE HORSE POWER AND HEAD WHEN φ IS CONSTANT.

FIG. 4.



CURVE BETWEEN $\frac{2\pi a L}{33000 H}$ AND $\frac{N}{\sqrt{H}}$

FIG. 6.

rence of explosions, and what conditions may render them impossible.

The points covered were as follows: *First*, the method of mining. The answers to this question confirmed the common belief that explosions in long-wall mines are almost unknown. Our records show only two cases. *Second*, the method of ventilation. This question was asked with the idea of learning whether the method of ventilation and the amount of air circulated in the mine have any direct bearing upon the question. *Third*, the presence or absence of gas. This question was asked with the idea of determining whether explosions ever occur in mines in which the presence of methane is not revealed by the ordinary methods of examination. *Fourth*, the presence or absence of dust in the mine. The answers to this question were expected to show to some extent the relation of coal-dust to explosions. It was recognized, however, that the replies would not be entirely satisfactory, because it is only very recently that the possibility of dust explosions has been widely recognized. *Fifth*, the presence or absence of water. This question was asked for the purpose of learning whether explosions have occurred in wet mines—that is, mines in which dust was not dry enough to float in the air. *Sixth*, the explosive used. This question was asked for the purpose of learning what, if any, connection might exist between the employment of explosives and the occurrence of explosions. As will be shown later, the connection may be a very intimate one. Besides these specific questions, others were asked which were intended to cover any points which might not have been covered in the preceding questions, so that all the conditions might be learned as far as it is possible to learn them by this method.

In addition to this a very large amount of literature has been read, and abstracts have been made of the valuable parts. The American literature on the subject has been quite thoroughly canvassed and a considerable amount of work has been done on the English, French and German publications. It was learned by this investigation that much of the supposed knowledge of the subject was not substantiated by such proof as to make it trustworthy, and certain experimental work has been done to positively demonstrate what was already believed to be true.

The lines followed in the experimental work were determined by the conditions of the industry in this country. These conditions are so well known that they may be dismissed with a word. Almost all of the coal mined in this country is obtained by the

room-and-pillar method, or some of its modifications. In this method the coal is broken down, not by the weight of the overlying strata, but by the use of explosives; and in American mining as now carried on explosives are used in very large quantities. A few years ago one can of powder weighing twenty-five pounds would frequently last two miners for a period of two weeks, and some of the powder would often be spoiled by dampness before it could be used. At the present time, in the fields of the Middle West, two miners commonly use from five to seven cans of powder in two weeks. The explosive used is almost entirely black blasting-powder, the so-called safety powders having been introduced to only a limited extent.

It was thought that the gases given off by the combustion of this powder might be contributory to some of the explosions which have been recorded. It is now also well known that the dust of some coals when suspended in air under certain conditions is explosive. The experiments then have been conducted principally along two lines—an investigation of coal-dust and an investigation of the gaseous combustion products of black blasting-powder.

A third series of investigations, which may be regarded as accessory to the other two, was an investigation of the explosive qualities of various gases in the form of simple mixtures with air, and of complex mixtures of gases and air. The gases used were such as are found in mines or in the combustion products of black powder, and the tests have made possible the prediction of the explosive or non-explosive quality of different mixtures which may be found in the mine atmosphere.

The behavior of gas mixtures has been tested under various conditions. It has been found that the presence or absence of water vapor makes a practically inappreciable difference. It has also been found that increased pressure causes little, if any, change in the explosiveness of the gases tested. In these experiments the gases were ignited by a flame, by a heated platinum wire, and by an electric spark.

The experiments on the explosive qualities of coal-dust have included a test of the dust of all coals which could be obtained, in which the explosive or non-explosive character of the dust when mixed with air was determined; and also the amount of dust which it was necessary to suspend in the air in order to make the mixture explosive. Other substances besides coal-dust have also been tested. These dusts were tested by placing them in a small box having a rotating fan in the bottom. Ignition was made in most cases by

the application of a flame. It was found that some dusts are much more explosive than others, and that when the dust is produced by pulverizing coal the least friable portion of the coal is the most explosive. The samples of the more and less friable portions have been examined under the microscope and the size of the individual grains measured, and it has been found that the more explosive portion contains a large portion of very fine grains, averaging about 0.003 of a millimeter in diameter, while the less explosive portion consists mostly of larger grains. By most explosive it is meant that a lower proportion of coal-dust to air is explosive. It will be seen that the surface of a grain 0.003 of a millimeter in diameter is very large in comparison with the volume, and that the opportunity for the occlusion of gases is very favorable; and also that such a grain could be heated in a very short time to the point at which gases would be distilled.

In the case of the only sample which has been obtained which had not been exposed to the air for an appreciable length of time it was found that the dust was not explosive, but that after about four hours' exposure to the atmosphere it became explosive. This sample was from the state mine at Lansing, and consisted of drill dust taken from the solid coal, none of which came from coal lying within three feet of the exposed face. Dust made by grinding lumps of this coal which had been exposed for a considerable time had been previously found to be explosive. When this fresh dust was collected it was sealed in a metal can. The can was so opened as to collect any gas which might have been given off by the coal. No such gas was found. Investigations are now under way to determine what change takes place in the coal during its exposure to the atmosphere. These investigations are incomplete, but show that oxygen is absorbed from the air. This absorption takes place even under a negative head of six inches of mercury.

The explosiveness of some of the dusts has also been tested in the presence of small quantities of natural gas, and it has been found that in some cases, in which both the gas and the dust are present in quantities too small for either one alone to be explosive, the combination is explosive. The same test was made using carbon monoxid and the same result obtained. It is therefore evident that the presence of even a small amount of explosive dust may be a source of great danger in case the mine air should contain a small amount of natural gas, or of combustible gases from any other source. And it should be noted that the safety-lamp which is commonly used for testing for gas indicates nothing less than about

two per cent. of gas; and that even this amount is recognized only in case the observer has keen eyes.

Tests have also been made to determine what, if any, gases could be withdrawn from the coal-dusts by placing them under a negative pressure. The results so far are negative, though it is believed that some coals would yield gases under such conditions. Gases driven off from the coal by increases in temperature have also been examined. The temperatures used were much below those used in the manufacture of coal-gas, the idea of the experiments being to determine what gases might be derived from coal-dust under such an increase of temperature as might be found under certain conditions in a mine; for instance, such as might be caused by the passage of a wave of compression of mine air into a blind passage.

The examination of explosives has been confined thus far to the black blasting-powder, which is the explosive most commonly used in American coal-mining. Its composition is approximately—

Sodium nitrate	73 per cent.
Sulfur	11 "
Charcoal	16 "

It is well known that the gaseous decomposition products of black powder contain carbon dioxid, nitrogen, carbon monoxid, methane, hydrogen and sulfuretted hydrogen, and sometimes small amounts of other gases, and that the combustible gases mentioned sometimes constitute a sufficient percentage of the whole gaseous mixture to make this mixture combustible. It was thought that this fact might have an important bearing on the subject, and a series of experiments have been conducted for the purpose of determining the gaseous products of the decomposition of black blasting-powder as it is now manufactured and the conditions under which large quantities of combustible gases are produced.

Our search of the literature of the subject disclosed the fact that no investigation along this line had been so conducted as to give its results any considerable value. The best work on the subject of black powder has been almost entirely confined to the study of gunpowder, which consists of potassium nitrate, sulfur and charcoal. Correspondence with the principal powder manufacturers of this country and some of Europe showed only that little was known of the action of black powder or of the conditions necessary to the production of large quantities of combustible gases. It is generally assumed that the substitution of sodium nitrate for saltpeter has no other effect on the powder than to make it more susceptible to damage by moisture in the air. This fact has prevented its suc-

cessful manufacture and use in England, but it is believed that no potassium nitrate black powders are used in this country. Apparently it is a fact that the use of sodium nitrate makes no important difference in the gaseous decomposition products.

The most careful examination of the decomposition products of gunpowder are those made by Abel and Noble of England and published in 1875 and 1880. Their experiments seemed to indicate, though not very conclusively, that the percentage of carbon monoxid decreases as the percentage of the volume of the containing vessel occupied by the powder increases; or, in other words, as the density of the products of composition increases. If this is the case, it would seem that the products of a blown-out shot in which the powder burns without doing much mechanical work should contain a comparatively large amount of carbon monoxid.

In order to test this point and others, a large number of experiments have been carried on. Powder has been burned in three different ways: First, by dropping the grains into a heated iron tube so arranged that the gases could be collected. This gave the gases at nearly atmospheric pressure. Second, by placing a considerable quantity in an iron tube and igniting it by means of a fuse, the gases being collected in a larger tube for the purpose of excluding air. This gives conditions approaching those of a blow-out shot. Third, by exploding the powder in a gas-tight bomb from which the gases could be drawn off as desired. The experiments have not confirmed the results indicated by the experiments of Abel and Noble, in that apparently the percentage of carbon monoxid does not decrease as the density of the composition products increases, but the change, if any, is in the opposite direction. The series of experiments is hardly sufficiently extended to make it advisable to give this as a positive statement, but the experiments so far conducted indicate this. It is sometimes stated that mining powder gives as much as thirty-three per cent. of carbon monoxid. If this statement is true, it evidently refers to the mining powder which has sometimes been used in England and which differs from gunpowder in the reduction of the percentage of saltpeter, and not to mining powder as used in the United States, which is fully nitrated, and gives about seven to ten per cent. of carbon monoxid.

To determine as far as possible the effect of coal upon the gaseous products of the powder, coal in the form of fine dust and in the form of larger grains has been mixed with the powder. It was found that carbon monoxid, methane and hydrogen appeared in greatly increased quantities, and that, in some cases, the gaseous

mixture would burn in the air. It is therefore evident that black powder, if used in a mine under such conditions as to produce large quantities of combustible gases, may be a source of great danger, especially if the mine contains explosive dust. The importance of the method of mining is evident in connection with this point. In the room-and-pillar method and its modifications from one to three shots are fired in one room. The gases evolved are therefore mixed at first with only a small quantity of air, and if these gases contain a sufficient quantity of combustibles an explosive mixture may result, while if the powder gases were mixed with a larger quantity of air the mixture would not be explosive. Explosions of mixtures of powder gases and air formed under these conditions are of frequent occurrence and may give rise to explosions of great importance.

The production of carbon monoxid during mine fires should also be mentioned, as some explosions have undoubtedly been due to the presence of carbon monoxid thus produced. A severe explosion at Hanna, Wyo., was apparently caused in this way.

As stated previously, the work is not finished, and this is to be regarded only as a preliminary report, not stating final conclusions, but constituting a record of progress. It is intended that this investigation shall be continued until as many as possible of the problems connected with it shall have been attacked and, it is hoped, solved. It is recognized that the question is a complicated one and that it deserves all of the serious attention which it is now receiving. The canvass of the literature of the subject will be continued with the idea of compiling as complete a bibliography as is possible. The laboratory experiments will be continued, especially along the lines of the investigation of coal-dust and of explosives. Up to the present time nothing but black blasting-powder has been studied. It is our desire to make a study also of the safety powders now being placed upon the market. It is also our intention to carry on a set of investigations at mines, testing the action of the explosives in actual use and examining the mine atmosphere.

SOME FLUCTUATIONS IN THE MINERAL CONTENTS OF THE KAW RIVER.

By F. W. Bushong and Archie J. Weith, University of Kansas, Lawrence.

UNDER the joint auspices of the State Board of Health and the United States Geological Survey a systematic examination of the river waters of Kansas was begun in November, 1906. Samples were collected daily from all of the larger streams of the state and forwarded to the department of chemistry of the University of Kansas for analysis. The results of these analyses are now being prepared for publication by the United States Geological Survey.

An examination of the analyses of the Kaw river water made previously by various chemists reveals the fact that the chlorin content is very variable. In a number of cases chemists not residing in the state, and unaware of this fact, have condemned this water on the basis of high chlorin being evidence of sewage contamination. While the Kaw is known to be polluted by sewage, the writers do not believe that its chlorin content furnishes any evidence whatever as to the presence or absence of sewage.

During the year 1907 six maxima were observed in the value of the chlorin in the ten-day composite analyses of water daily collected from the Kaw at Holliday. At each of these maxima the number of parts of chlorin per million was sixty or more, while the minimum was as low as eleven parts. An examination of the record of the turbidity of the three tributaries of the Kaw—the Saline, Solomon and Smoky Hill rivers—shows clearly that the maxima referred to are produced by fluctuations in the flow of these saline streams, viz.:

Periods of maximum turbidity.	Cl. maxima of the Kaw.
Smoky Hill, January 18–29.....	January 29 to February 7.
Smoky Hill, March 27 to April 7....	April 12–23.
Smoky Hill, May 3–15.....	May 14–23.
Saline, June 23 to July 5.	
Solomon, June 27 to July 8.....	June 30 to July 9.
Saline, August 16–26.....	August 29 to September 7.
Saline, September 29 to October 10.	October 9–18.

Similar variations are observed in the quantities of other constituents.

ANALYSIS OF SPICES.

By L. E. Sayre, University of Kansas, Lawrence.

ONE of the difficult classes of vegetable substances to analyze satisfactorily is the class known as the spices. The quality of food accessories and their value for medicinal use resides mainly in two constituents—an aromatic volatile oil, and a resin, oftentimes pungent in character. In the case of ginger we have a volatile oil, 1 to 3 per cent, which imparts the odor and flavor of the drug, and a non-volatile resino-extractive to which the pungency is due. To these two principles the ginger owes its special activity. The constituents of ginger that may be neglected practically in chemical analysis are starch, fat and other inert principles, but starch is an important constituent in microscopical analysis.

The volatile constituent above referred to is readily extracted and separated from inert material by alcohol, ether, benzol, or by carbon disulfid. From good ginger ether extracts from 4 to 8 per cent. of an oleoresin, which contains the volatile oil and pungent principles. The ash from good ginger amounts to from 4 to 5 per cent. The presence of a very minute quantity of an alkaloid has been noted, but in estimations of quality this possible constituent is ignored.

According to the provisional methods for the analysis of spices in general, the Association of Agricultural Chemists recommends that the following data be obtained: Percentage of moisture, percentage of ash, of water-soluble ash, of ash insoluble in acid, of lime, of nitrogen, determination of ether extract (volatile and non-volatile), of alcoholic extract, of reducing matters, of starch, of crude fiber, and of tannin. For extracting ginger the percentage yield of cold-water extract is obtained, and for mustard the percentage of total sulfur, beside the microscopical examination. It will be seen that this process is quite an elaborate one if all these data are obtained. In certain individual spices only a few of these are essential, as in the case of ginger the United States standard requires that it shall contain not less than 42 per cent. of starch, not more than 8 per cent. of crude fiber, not more than 6 per cent. of total ash, not more than 1 per cent. of lime, and not more than 3 per cent. of ash insoluble in hydrochloric acid. In the limed or bleached ginger the standard is: It should contain not more than 10 per cent. of ash, not more than 4 per cent. of carbonate of lime,

and conform in every respect to the above standard. It is clear that in order to obtain these data considerable time and labor are required, and when one has to run through a set of several dozen samples it involves an expenditure of time and labor which is, in some cases, unnecessary, and is certainly uneconomical from the point of view of those who have to bear the expense of the time, the expert help, and the material consumed.

It becomes, therefore, desirable that a rapid method, as a preliminary one for quickly separating the substandard and standard material, be employed. A somewhat indirect method of such a character has been suggested by E. Beckmann, which he calls the cryoscopic method. Mr. Beckmann reviews the difficulties the other processes involve, and these difficulties led him to devise one as above characterized. He based the estimation of spices on the rapid determination of the percentage of volatile-oil constituent. The solvent employed for the extraction of the volatile oil is ethylene bromid, on account of its high molecular depression. The examination is performed as follows: Five grams of the powdered drug are macerated in an Erlenmeyer flask for one day with 30 gm. of anhydrous ethylene bromid. As the drug floats on the surface of this liquid it is completely exhausted without much shaking in from eight to ten hours. The solution is filtered through wool, with the aid of the filter-pump, directly into the freezing tube or apparatus, and the freezing-point determined in the usual way, the bath being maintained at 5° to 6° C. The depression of the freezing-point below that of ethylene bromid observed is due partly to the volatile oil and partly to other substances dissolved by the ethylene bromid, and to obtain the former alone a second experiment must be made with a portion (5 gm.) of the drug freed from volatile oil by driving through it a current of steam at 130° C. The drug after this treatment is quite dry and can be used at once for the second extraction. The difference between the depression observed for the crude spice and for the spice deprived of volatile oil gives the depression due to the volatile oil. For estimating the quality of a spice by comparison with one of known standard strength, it is only necessary to make a determination using the standard as one, and another using the sample example to be estimated.

While Beckmann's method is comparatively short and rapid, it is less elaborate than process of extraction with petroleum spirit or ether and estimation of volatile ether extract. It has some of the disadvantages of the volatile ether extract method, in that it bases the estimation mainly on the volatile oil. In many cases the

pungent resin or oleoresin is a very important ingredient of the spice, and we feel that this pungent substance should be considered in the preliminary test.

In order to quickly eliminate substandard material among the spices it has seemed to us that if the examination utilized the value of sense of taste, applying it to certain standard solutions, it would go far toward accomplishing the result sought. It has been determined that the sense of taste is even more acute and delicate than chemical analysis seems to be. It has been stated by certain analytical chemists that they were so positive of their results in the determinations they made by using the sense of taste or odor that they were willing to testify in court having no other basis for the testimony than this. One of our famous chemists, especially expert in the examination of unsanitary waters, makes the statement that they can unerringly detect certain forms of algæ in the water by odor alone, previously heating the same to a certain degree. So positive are the results that they are considered sufficient for court cases. Another one of our most able chemists, who is especially expert in the analysis of vanilla preparations, makes the statement that he considers no one an expert analyst for vanilla preparations unless he is able to detect minute quantities of tonka beans, if any have been added to the vanilla extract. Tea specialists depend entirely on the sense of taste, and they become so expert it is well known that they can grade the article with accuracy.

Prof. E. H. S. Bailey has ascertained that the delicacy of taste is so remarkable that an average person would detect one part of quinine in 500,000 of a solution. He has ascertained, also, that this delicacy of taste is to be considered in the following order: (1) bitter; (2) sweet; (3) acid; (4) alkaline; (5) saline. The order of delicacy for aromatics was not determined.

One of the first to recognize the value of the sense of taste in estimating the quality of a drug was Dr. E. R. Squibb, who suggested a physiological test for the standarization of tincture of aconite, which was about as follows: In the absence of any reliable chemical tests for aconitine E. R. Squibb suggested that a fluid drachm of a highly diluted solution of the various preparations be taken into the anterior part of the mouth (after the latter had been thoroughly rinsed) and held there one minute by the watch, and then discharged. The peculiar numbing sensation charcteristic of aconite should be experienced within fifteen minutes, and it should continue for fifteen or thirty minutes. Tested in this way, he found he could estimate the values of the various commercial aconitines.

He found, for example, that to be a standard 1 grain of good powdered aconite root is equal to $\frac{1}{8}$ grain of Merck's ordinary aconitine, $\frac{1}{38}$ grain of Merck's pseudaconitine, $\frac{1}{111}$ grain of Duquesnel's crystallized aconitine (really aconitine nitrate). He also found by this approximate method that 1 grain of powdered aconite root was equivalent to 1 minim of fluid extract, $\frac{1}{6}$ grain of alcoholic extract of aconite root, 2.66 minims of U. S. (1890) or 9.31 minims of U. S. (8th revision) tincture of aconite root, 8.43 minims of British tincture of the root, 11.8 minims of German tincture of the root, 1.5 minims of Fleming's tincture, 9 grains of powdered aconite leaf, 1.5 grains of alcoholic extract of dried aconite leaf, 1 grain of Allen's English extract of fresh plant, and 72 minims tincture of aconite leaf.

To employ this physiological method, employing sense of taste in the estimation of spices, an alcoholic extraction of definite strength of the aromatic and pungent principles should be made and this solution diluted to a maximum with water, the latter added to the limit of precipitation. The solution is then brought in contact with the gustatory nerve endings, and in order that a comparison be made a uniform dilution should be made of all samples to be compared—one that will bring out the aromatic and subdue the alcoholic constituents. When this has been properly done, an estimation can be made much more readily than by tasting the crude spice in powder. It requires practice to make the method available for the purposes of comparison, but one soon becomes quite expert. It is well known that pungent substances, such as pepper, obscure any gustatory sensation, therefore a solution of pepper must be highly diluted to make it serviceable. It should be said that tastes do not develop promptly. In some cases a considerable time must be allowed to elapse before the taste is well developed. This is doubtless due to the slow miscibility of the sapid and pungent substances. At best the process is to be considered only as a preliminary one for quickly eliminating substandard materials. It is this preliminary test that would be so useful were it made practical for rapidly selecting from a given number of samples those inferior ones that should be set aside for more careful examination by more elaborate methods. As has been stated, the microscope quickly identifies a spice adulterated with foreign material, but a substandard spice, containing all the microscopical elements of the standard material, the microscope is powerless to detect.

REPORT ON ANALYSES OF PREPARATIONS UNDER THE PURE FOOD AND DRUGS LAW.

By L. E. Sayre, University of Kansas, Lawrence.

IT IS well known, perhaps, that the work of drug analysis under the direction of the Board of Health is located at the University of Kansas. It has been thought desirable to make a few remarks at this time as to the progress of the work and some of the problems with which we have to deal.

A separate laboratory is set apart for the investigations and analyses, and one person, Mr. Adolph Ziefle, devotes the major part of his time to the work. Some of the investigations, which require research for which the regular analyst has not the time to devote, is taken charge of by Mr. L. D. Havenhill, who has a special research room for his purposes. Mr. Havenhill will in the future do a considerable amount of investigational work, which will bear directly upon the question of standards. It is well known that Mr. Havenhill has spent a year under the United States Government in Washington and in New York at the appraisers' stores.

The microscopic work, which is one that requires a specially trained man, is taken charge of by Mr. Chas. M. Sterling. But to Mr. Ziefle comes the burden of the mass of analyses that is pouring into the laboratory weekly. The difficulties that he encounters are very numerous, because of the fact that he has such a great variety of materials to deal with, and this variety comes in every collection sent in by the inspectors. If it were possible to take one particular article and run an hundred analyses on this same article, it is easy to see that this would be very much simpler than if the hundred articles should contain from fifty to sixty different kinds of analyses, each of which requires different solutions and reagents to be specially prepared.

One of the difficulties which we have recently encountered relates to the subject of deterioration. This has become a very provoking problem. The question has arisen, What shall be considered as deteriorated; what chemical tests and what chemical results will prove that a substance is deteriorated?

The difficulty appears to be to determine what would be considered legally as "deteriorated"—what terms should determine this condition. Some regulation or definition to meet the case might be suggested, such as the following:

By deterioration is meant, first, a deviation from the professed standard.

The professed standard is regarded as that condition represented by the preparation when it is freshly prepared. Such deviation from the professed standard as above referred to may be determined by :

(*a*) Microscopical examination. If a medicinal liquid shall be found by microscopical examination to have become so decomposed that bacterial germs and germs of decomposition are found therein, it shall be considered deteriorated.

(*b*) Chemical examination. If by chemical examination any of the professed ingredients, such as pepsin, pancreatin, or any of the other ferments, be found absolutely inactive, or if a cocoa preparation give no reaction, showing the absence of the alkaloid, etc., such preparation shall be considered deteriorated.

(*c*) Macroscopical, etc. If a preparation differ in appearance materially from that freshly prepared. If, for example, there have developed a precipitate evidently through aging of a liquid, or if it should from odor, taste or other physical tests show evidence of impairment or decomposition, any of these conditions shall be taken as ground for deeming the article deteriorated. Any deteriorated drug products offered for sale shall be liable to the application of regulation 30 of the food and drugs law.

THE LACTOSE-BILE TEST FOR THE COLON BACILLUS.

By W. B. Wilson, Ottawa University, Ottawa.

THE discovery of *Bacillus coli* in 1885 by Escherich, followed by the proof that this micro-organism is a normal inhabitant of the intestines of mammals, especially of man, has led bacterioscopists to pay special attention to its isolation. Since *B. coli* is always found in sewage and polluted water, and since it is comparatively easy of detection, this germ is taken as a most valuable index of the sanitary condition of potable waters.

In presumptive tests, the common practice has been to employ a dextrose broth made by adding two per cent. of dextrose to the common French bouillon in the ordinary fermentative tube. The bacterium attacks the dextrose, liberating carbon dioxid and hydrogen, which is taken as indicative of the presence of *B. coli*, or at any rate a sugar-loving, gas-forming bacterium.

Unfortunately this test is not always reliable, especially when negative results are obtained owing to the interference of other

bacteria. This is especially so in badly polluted waters, in which case the gas-forming bacteria may be much overgrown and crowded out by non-gas-producers. Hence, analysts have sought diligently for a medium which would restrain the non-gas-producing bacteria, and at the same time not interfere with the normal action of the gas producers.

In the Supplement to the Journal of Infectious Diseases, May 3, 1907, Daniel D. Jackson presents an article on the "Use of a Lactose-bile Medium" which at that time had proved to be reliable in presumptive tests for *B coli.*

The lactose-bile medium is prepared by drawing liquid ox bile directly from the animal and sterilizing it. The bile is then filtered and to it is added one per cent. of lactose previously dissolved in a small amount of water, after which it is drawn off into fermentation tubes and sterilized in an autoclave for thirty minutes at fifteen pounds pressure. The ordinary plain fermentation tubes may be used, but Jackson recommends tubes 140 mm. long and 15 mm. in diameter, having an elongated bulb 38 mm. in its shortest diameter. This admits of the use of a considerable quantity of the water to be tested without too great dilution of the medium.

Mr. Jackson reports that at Mount Prospect laboratory, Brooklyn, N. Y., about 5000 samples of water of various degrees of purity and from hundreds of different sources have been tested by this medium and the results agreed with the judgments formed by the complete analyses of the samples as well as by careful sanitary inspection of the sources of supply. In many instances contamination has been found to exist which would not otherwise have been detected.

The extreme efficiency of this ox-bile medium in tests for *B. coli* is due to the selective inhibiting power of the cholic acid radical of the bile by which bacteria other than the colon bacillus are restrained or killed. Nearly all the bile salt present is in the form of a glycocholate. Experiments show that no meat extract is needed, as the bile contains albuminous matter enough to feed the bacteria.

It has been the practice at the Ottawa laboratory to procure from the local butcher ox galls in sufficient number to yield a quart of bile at a given time. The bile is drawn out, autoclaved and kept in plugged flasks in a liquid form until needed. It may be evaporated to dryness and kept in the form of powder. In this case, however, it must be perfectly dry or in a short time it will become too acid for use. A gram of lactose, 11 grams of solid bile

salts, and 100 cc. of water give a combination which is equivalent in results to the medium made from fresh liquid ox bile.

Presumptive tests with this medium are not only more reliable than those employing other media, but are easily made, requiring the minimum skill in application. The lactose-bile medium is especially valuable in testing wells, cisterns and filter plants.

III.

GEOLOGICAL PAPERS.

1. "Drainage of the Kansas Ice-sheet."
   By J. E. Todd, University of Kansas, Lawrence.
2. "Expedition to the Laramie Beds of Converse County, Wyoming."
   By Charles H. Sternberg, Lawrence.
3. "Study of Certain Features of the Lawrence Shales."
   By J. A. Yates, Manual Training School, Pittsburg.
4. "The Skull and Extremities of Diplocaulus."
   By S. W. Williston, University of Chicago, Chicago, Ill.
5. "Notes on the Olympic Peninsula, Washington."
   By Albert B. Reagan, La Push, Wash.
6. "The Carboniferous Quadrupeds of Kansas, Ohio, Illinois and Pennsylvania in their Relation to the Classification of the so-called Amphibia and Stegocephala."
   By Roy L. Moodie, University of Kansas, Lawrence.
7. "Formations of the Marion Stage of the Kansas Permian."
   By J. W. Beede, University of Indiana, Bloomington, Ind.
8. "An Armored Dinosaur from the Kansas Chalk."
   By Charles H. Sternberg, Lawrence.

DRAINAGE OF THE KANSAS ICE-SHEET.

By J. E. Todd, University of Kansas, Lawrence.

OUR subject has been so shortened for convenience that it is too broad for the intended scope of our paper. We have not time to consider the drainage of the whole ice-sheet of the Kansan epoch in the United States, but only that of its western side, and particularly that in the state of Kansas. It is scarcely necessary to state that it was in the Kansan epoch of the ice age that the great ice-sheet reached its maximum extent; that in the Iowan, which has not been satisfactorily traced in the Missouri valley, the ice did not extend as far by 150 to 200 miles in this direction.

PROBABLE MARGIN OF THE ICE AT THAT TIME.

Some have conceived that the center from which the ice deployed at that time was a point west of Hudson's Bay, called the Kewatin. They have assumed that the ice which entered Kansas came down the James and Missouri river valleys through Dakota and Nebraska. Such a conclusion, however, seems forbidden by the following facts:

1. It would have been impossible for such a long, slender lobe to have maintained itself for 500 miles, with one side exposed for that distance to the heat and warm winds of the western plains. Moreover, the height of the ice in Dakota, necessary to give head sufficient for such a course, must have been attended with a much greater western movement in that latitude than is indicated by any trace yet discovered.

2. Northeastern Kansas would have been more accessible to a Canadian ice-sheet through the Des Moines valley rather than through the Dakota. The distance is shorter, and preglacial surfaces rise 1500 to 1700 feet above sea in northeastern Nebraska. Besides, no clear trace of Kansan drift has yet been found in Dakota.

If it be objected that the divide between the Des Moines and the Missouri is too high, particularly when southeastern Iowa is so much lower, it may be replied that 200 to 350 feet of the divide is glacial till, and that the older surface is not over 1000 feet altitude, and in the northern part, where the more easily eroded Cretaceous rocks are found, cases are reported of preglacial surfaces less than 800 feet above sea. Moreover, there are other reasons for believing the east was relatively higher at that time.

3. Glacial striæ in eastern Nebraska and northeastern Kansas indicate that the main movement in those regions was from the northeast. Those which indicate other movements are low down in valleys and correspond to a thin and wasted stage of the ice. Some recorded are the following: Omaha, S. 41° W.; Bennet, S. 17°, 41°, 43°, 61° and 88° W.; Weeping Water, larger grooves, S. 29° W.: St. Joseph, Mo., 125 feet above Missouri river, S. and S. 26° W.: near Seneca, Kan., S. 21°-24° W.

A collection of more characteristic boulders sent to Minnesota geologists were found to agree, most of them, with ledges found within the borders of that state. Perhaps 90 per cent. of the boulders in Kansas are varieties of red quartzite from the Algonkian of southern Minnesota and South Dakota. Nebraska geologists have usually referred similar ones in their state to Dakota, but a striking feature of many of them is the abundance of white quartz pebbles in them. Such rock is found in ledges in Cottonwood and Rock counties in southwestern Minnesota, but is not prominent, if found at all, in South Dakota. This is very likely due to the former being nearer the parent granitic rocks which furnish the framental material.

Again, if the quartzite came from Dakota it would naturally have been on the east side of the Dakota lobe and not on the extreme western margin of the drift, as we find the boulders in Kansas. On the other hand, if from Minnesota the observed distribution would follow.

We conclude, therefore, that the western limit of the ice during the Kansan was probably not west of the Coteau des Prairies in eastern Dakota, thence south-southwest across Nebraska, a little west of Fremont and Lincoln, Neb., and east of the Big Blue into Kansas and south in that state to the Kansas river, perhaps, near Topeka, but probably not to that stream further east until near the Missouri, reaching the vicinity of Kansas City.

THE LINE OF THE MASTER DRAINAGE STREAM.

Probably the James river approximately marks the course of that ancient stream through the Dakotas, the Big Sioux joining it near Vermilion, S. Dak. Its level was doubtless relatively higher than now, for the erosion of the Cretaceous clays, which cover that region, by the Iowan and Wisconsin ice-sheets was no doubt great.

Through Nebraska its course was perhaps south-southwest to the Elkhorn near Westpoint, which stream it may have followed always, thence we may suppose across over the present low valley of the Platte and across lower places in the hills south past Val-

paraiso to Milford on the Big Blue, which it followed approximately to the Kansas and the Kansas to the Missouri.

This may have been the line when the ice was at the maximum; but later lines, which may have been occupied longer when the ice was pausing in its retreat, may be followed now by Logan creek to the Elkhorn, by ancient valley along Sand creek and Wahoo creek in Saunders county, by Salt creek, and over to the Big Blue, near Crete. It is conceivable also that a lake basin may have occupied portions of the route at different times, particularly between the Elkhorn and Blue.

After reaching the Blue the route is comparatively clear. It followed down the course of that stream with an overflow, either in earlier stage or in time of flood, across to the Little Blue at Fairbury, Neb., and then down that stream back to the main stream. From the mouth of that stream it followed approximately the course of the Kansas river to the Missouri, at Kansas City. We say approximately, for the stream was at first about 200 feet higher than the present stream and there are numerous cases where channels crossed the present divides between that stream and its southern tributaries, for a distance of ten to fifteen miles in places, from the present Kansas.

Through Nebraska, stream deposits have not been traced over much of the distance, doubtless partly because diligent search has not yet been made. Along the Blue and Kansas they are frequently found at different levels. The most characteristic deposits of the higher terraces and channels are strips of boulders mingled with gravel and clay. The boulders are of local limestone mingled with crystalline rocks from the north, particularly the red quartzite before mentioned.

The highest level of drift terraces is about 1000 feet above sea, at a point southwest of Lawrence; 1050 to 1100 southwest of Topeka, and about 1200 south of Wabaunsee. At Fairbury, Neb., gravel occurs about 1325. To pass over the divide between the Blue and Salt creek an altitude of about 1425 is necessary at Berks, and higher farther north. Probably somewhat greater altitude would surmount the divide between the basin of Salt creek and Platte river near the northwest corner of Sanders county. Northwest of Westpoint, Neb., stratified deposits containing drift occur at less than 1450, but, as suggested before, the line may have followed up Logan creek. To pass the divide from that stream to the Missouri and mouth of James river would have required 1650 at least; and to reach the Missouri by way of Aoway creek, probably 1500 feet.

This would imply a stream 275 to 300 feet higher than the present James river, occupying at that time the valley of that stream, which would seem an insurmountable objection to our conception. There are three things which reduce the difficulty. First, by noting that the Wisconsin ice-sheet may have removed 150 to 200 feet depth from the bottom of the valley. There seems to be some evidence of this when we find bed-rock considerably over 100 feet higher on the south of the Missouri at Yankton and Vermilion, S. Dak., than on the north side of the same. Secondly, there may have been more or less of lacustrine conditions between the Missouri and Big Blue rivers in northeastern Nebraska. This agrees with the lack of coarse stratified deposits in that region, so far as is yet known. Yet the pebbly clay shows unusual stratified features near Westpoint and west of Fremont. Thirdly, the more recent elevation of central Kansas, or the depression of areas toward the northeast, in Iowa and Wisconsin.

At Blaine, Pottawatomie county, Kansas, nearly at the extreme advance of the ice in that state, clear evidence is shown that localities over 1500 feet above sea-level were swept over by the ice-sheet. This is nearly twice the altitude of central Iowa. How then could the ice have taken such a westerly trend, with lower or equal plains southeast, in southeastern Iowa and Illinois, unless there had been an appreciably western or southwestern slope of the preglacial surface? Such a condition would have rendered the drainage line suggested considerably more rational. As we have found it the slope seems much too steep eastward down the Kansas and too flat or sluggish from the Missouri to the Blue.

A speculation easily following from this conception is that not long before the glacial advent, possibly the difference in slope of the surface may have been enough to have reversed the flow in the valley of the Kansas and it may have flowed via Salina and McPherson through the buried channel at the latter place into the Arkansas river. The accumulation of the ice on the northeast may have reduced the slope of the stream so that it aggraded rapidly, so that the McPherson channel was filled, and when the great stream draining the west edge of the ice-sheet arrived, the surface in time was tilted so that the drainage was eastward around the edge of the ice, as we have seen.

PLEISTOCENE AND MORE RECENT EROSION.

Doubtless to some a great objection to our view will be found in the amount of erosion which it assumes. It really infers that the main valley of the Kansas river was three to four miles wide and

200 feet deep, at least that below Manhattan, and those of its tributaries have been excavated since the ice first reached its maximum limit.

It has been assumed by some that this main valley was preglacial, because large northern erratics are now found in its bottom and under heavy alluvium; but a moment's thought will show that it would not be otherwise if these boulder deposits had been let down by undermining, from terrace to terrace, in erosion which was subsequent to the advent of the ice. Perhaps the idea was at first received because these boulders were so deeply covered with alluvium. Not long ago it was thought that the recent alluvium of a stream could not exceed 20 or 25 feet, but now it is known that it may exceed 100 feet. (See Bulletin 158, U. S. Geol. Survey, p. 150.)

That the general surface of the region and level of drainage was high at that time is indicated in several ways: (1) Glacial deposits are limited to higher levels. About Kansas City glacial striæ have not been found lower than about 125 feet above the Missouri river, or 850 A. T. (2) The till in Kansas lies on the divides but has not been found in the valleys. (3) At Weston, Mo., a cobble-stone stratum, about 20 feet thick, lies upon Carboniferous shales about 150 feet above the Missouri. It contains red quartzite and granite boulders, mingled with many of limestone. It seems therefore to show that the river was flowing at that level when glacial erratics entered the region. As already stated, the earliest bouldery strips beyond the edge of the till in Kansas were at high levels. We may imagine the shallow pioneer streams around the front of the ice, as assisted by floe-ice and anchor-ice.

The erosion of valleys 200 feet deep, and mainly during the Kansan epoch, may seem too much for the credulty of some, but there are several considerations which may make it more plausible.

1. The probable volume of the stream. The whole western slope of the great ice-sheet of that time probably included half of the Dakotas, much of Minnesota, Iowa, Nebraska, Kansas and Missouri. Omitting the last as not affecting our problem, but remembering that probably as much in Canada as that enumerated which would drain this way, we may reasonably count the ice-surface contributing as over 200,000 square miles. The amount of ablation or melting of Alpine glaciers has been estimated by DeSor as ten feet a year; by Forbes as twenty feet, and even two and one-half inches a day have been reported. Taking five feet as a conservative average, we should have a little less than 100 cubic miles

a year. The Missouri is estimated to discharge an annual average of 24.41 cubic miles. Let the drainage from the west be counted as somewhat more than at present, because of a moister climate then, and we can readily believe that the Kansas of that time may have averaged five times the present Missouri, with possibly ten times in unusual years.

2. The country rock of the region is mainly shale and shaly sandstone. The limestone comprises less than one-tenth and is in comparatively thin layers and small blocks. Such an arrangement affords conditions very favorable for rapid erosion.

3. It was probably a time of greater variation of volume in streams and also of frequent freezing and thawing. Both tended to increase the erosion.

What corrasion such a stream would accomplish can scarcely be conceived, but it may be believed to have been fully adequate to the work supposed.

Again, the length of time during which this line of drainage was occupied was long. Students of glacial deposits tell us that since the culmination of the Kansan ice the time has been from 330,000 to 1,000,000 years. A meager 1000 years might be allowed for the life of the great stream which we have sketched, and, from considerations we have entertained, it would seem much less time might be sufficient to excavate the valleys as we now find them. The chief delay was doubtless the cutting down of the heavy limestones which lie athwart the course of the Missouri river in eastern Missouri.

This discussion is but a preliminary sketch of the problems involved in Kansas Pleistocene geology. Our inferences are tentative only. Careful study may modify them in unexpected ways, yet we believe we are on the right track in several particulars. The coöperation of all interested in the subject is hopefully solicited.

EXPEDITION TO THE LARAMIE BEDS OF CONVERSE COUNTY, WYOMING.

By Charles H. Sternberg, Lawrence.

THE beds consist of gray or yellowish sandstone, interlaid with redish and gray clays, and small beds of marl made up largely of fresh-water shells. The sandstone is massive, or cross-bedded, and scattered through it are concretions, usually shaped like small marbles, up to the size of large cannon-balls, eight or more inches in diameter. The most remarkable peculiarity of the sandstones are the singular shaped masses of brown siliceous material, flint-like in structure, and of the same physical conditions as the soft sandstone in which they are imbedded; either stratified or cross-bedded. They assume every conceivable form, from flattened disks to masses over a hundred feet long and less than a yard in width and thickness. They often bridge a chasm, or roof a cave, and where they are circular in form they protect the underlying strata, which rises in columns. Often many stand up free and resemble a colony of enormous mushrooms.

Fantastic forms are everywhere visible, the sculpture different than in any other formation of exposed rock I have explored. Here is the head and bust of a woman wearing a great "merry widow" hat; there a laughing baby; yonder a huge bird, sitting on a nest; and every other form the mind can imagine. As the sandstone is only held together by cohesion it disintegrates readily, and ravine after ravine is carved out of the surface of the country.

The cross-bedded strata leave marks where sections are made like the contour lines on a topographical map. In them are yellow streaks of iron oxid, as well as seams of lignite, and iron concretions; showing all that is left of some ancient bayou or marsh once rich in swamp vegetation. The iron it collected now marks their boundaries. Here, as would be imagined, are bone-beds, filled with scales of ganoid fishes, teeth of dinosaurs and other reptiles, and also teeth and bones of the rare mammal; for the Laramie of the Upper Cretaceous here is indeed the border-land between the age of reptiles and that of mammals. The great dinosaurs will appear no more in the earth's history, but a vast array of mammals hereafter will dominate land and sea. We find here also the beautifully sculptured bones of the fresh-water turtle *Trionx*, and others. I found also numerous teeth of a ray, *Myledaphus*. I discovered the type

in Montana in the similar Judith river beds, where, as assistant of Prof. E. D. Cope, we found also the first dinosaur remains in western America, except for a few teeth that Dr. F. V. Hayden found at an earlier day.

Above the cross-bedded sandstone are beds of red or gray clays topped by a stratum of flint-like structure that readily flakes off and covers the surface with angular fragments. We looked with earnest hope for the great land reptile *Triceratops*, and were so fortunate as to find a huge skull six feet and six inches long, which I sent to the British Museum.

From the remarks already made you will expect a rough and hilly country, and so it is. The main drainage canals open into the flood-plain of creek or river, but as they retreat into the hills they scour the country into deep gorges and lateral ravines. They cut through great masses of the easily disintegrated sandstones and clays, undermining hardened masses, to bridge some chasm or crown a butte or table-land that towers above in silent grandeur, breaking the monotony of this cut-up land, and serve as landmarks to the venturous fossil hunter who, without guide or compass, enters these vast solitudes. The lateral ravines often meet and cut off a table-land, which gradually forms a haystack-like butte which stands up above the surrounding country, isolated or in groups, against the distant horizon.

This region, covering many square miles, is destitute of human life except for a few sheep and cattle men and our little party of four fossil hunters—the father and his three sons. It occupies a great basin whose outer rim is formed by the rocks of the Fox Hills and Fort Pierre of the Cretaceous. These beds mark the old shore-lines of the lakes and morasses that once occupied the country. The Fox Hills consist of yellow sandstone with great brown concretions filled with shells—amonites, graphites and bivalves, and other forms of marine life. The Fort Pierre consists chiefly of black clays in shaley structure, and contains a rich fauna of Baculites and other shells. I saw Baculites that must have been over three feet long.

These vast deposits were land when the lakes of the Laramie existed, and the rivers cut out their clays and sandstones to form the thousand or more feet of its strata. A tropical or semitropical climate, the land 5000 feet lower than at present, bayous and lakes lined with dense growths of cat-tails and other swampy vegetation, while the firmer ground supported palmettos and other trees. I see the narrow stream that silently winds among the rushes disturbed by the vibrations of a powerful tail, whose undulatory mo-

tions send off ripples in semicircular waves toward the rushes that border the land on either shore. Suddenly the water is calm, and a huge head, three feet in length, appears above the water. It is supported on a strong neck and powerful body. The expanded front part of the head forms a duck-bill that is covered with horn with sharp cutting edges, while farther back are magazines containing 2000 teeth, arranged like a pair of scissors on each side of the mouth, that shear the swamp vegetation which his clumsy hands draw into his mouth. With hind feet resting on the bottom of the stream, we cannot realize the size or power of this animal, until, weary of feeding, he pushes through the dense foliage, puts his front feet on the land and gently draws himself out of the water. A great reptile indeed! His front limbs are five feet long, shod with three hoofs and provided with an additional finger or thumb without a hoof. His huge hind limbs, eight feet long, elevate his beautifully rounded hind quarters far above the ground. He has three large toes, covered with massive hoofs, on each foot. His great flattened tail follows. As he rises on his hind feet to shake off the water that falls in cascades, the sun shining through it reveals the colors of the rainbow.

There he stands, full twenty feet in height, with his great tail, ten feet long, stretched out behind. He darts his flattened duck-bill in all directions, scenting the air, and, as if satisfied, drops to the ground and moves gracefully along on all four feet. His flexible skin is covered with scales in diamond-like patterns, arranged in horizontal and longitudinal rows. Octagonal scales fill the diamond pattern, while smaller ones, often no larger than a small pin-head, fill the spaces between. These highly colored and glittering scales blend in perfect harmony with the richly colored vegetation. Hark! What is that sound that breaks upon the ear like the roar of Niagara? Our duck-bill turns toward the water and by leaps and mighty strides seeks safety from his deadly enemy. Too late! too late! for as he cowers on his front feet and uses his powerful hind limbs as levers to assist him to spring to safety far out in the deep water, a bolt with the roar of thunder strikes him with a shock that makes the earth tremble, and the beautiful reptile receives a mortal wound and falls into the water to almost instantly sink, and a mightier than he strides the shore, giving vent to angry howls that reverberate through the forests. He is in full view for a moment, and proves to be the great tyrant of his time, *Tyrannosaurus rex.* There he is, standing on his hind feet, thirty-nine feet high, armed with great dagger-like teeth and powerful claw-

armed feet, known to science as the most terrible of the carnivorous dinosaurs.

After a few days gases form in the stomach of the dead *Trachodon*, or duck-billed dinosaur, and raise the carcass which floats on the water with back beneath and arms stretched out at right angles to the body, driven head first with the current. The head drags under the body as it drifts along; some hungry beetles have eaten through the walls of the abdomen, the gases escape and the mighty carcass, thirty feet from beak to end of tail, when the fleshy walls of the abdomen collapse, sinks to rest and burial in the quicksands below. The sand drifts into the body cavity and keep the walls in their normal position. Ages pass. Slowly the sepulcher, with all the continent west of the Mississippi, is raised to the tune of the rushing waters of the Colorado, that cut with sand and gravel a channel as rapidly as the country rises. A cañon carves through the graveyard of the *Trachodon*, cutting off and disintegrating the tail and hind feet. But before further damage can be done, in the year of our Lord 1908, late in August, two Sternbergs, with hungry eyes for ancient bones, stumble upon the grave after weeks and weeks of unremitting toil, and in a region that had been worked for years by collectors. Yes, after forty years' labor for science, lest my pride in the discovery might be too much for me, my two sons, George and Levi, have earned the glory of discovering the best specimen of a dinosaur of this form ever found.

Time would fail me to tell of all the anxiety and labor before it was delivered in the American Museum, in New York. And how, with the assistance of Professor Osborn's ablest preparators, we uncovered enough to show the bones lying in natural position, wrapped in the impressions of its folding skin. I left New York with the assurance that it would be mounted as in death. The only necessary restorations are the hind feet, one tibia and fibula and the tail, which had unfortunately been cut off by the wash. The open mounts of two fine *Trachodon* skeletons, and all that may be found, must be changed to compare with this standard, as its preparator was God Almighty. In addition to the facts enumerated, the contents of the stomach are carbonized within the abdominal cavity, and the muscles have left their impressions above the bones in the fine sandstone. With this skeleton before us, and those already known, we shall become as familiar with the old duck-bills as we are with the horse or ox or dog.

STUDY OF CERTAIN FEATURES OF THE LAWRENCE SHALES.

By J. A. YATES, Manual Training School, Pittsburg.

DURING the development of the economic resources of southern Kansas some rather interesting facts have been noticed and commented upon from time to time by those who have studied the surface of the country, especially those who live in the area of the gas belt, this territory having been hastily crossed by geologists and certain facts noted, such as numerous mounds, and reddened sandstone, as though it had been burned. Sandstone dipping twenty to thirty degrees, and at one place quartz crystals abounding, caused our state geologist to send me to study these facts and to ascertain, if possible, the causes therefor. The first place studied was the so-called "Silver City."

I found Silver City to be situated nine miles east and two and one-half miles south of Toronto, in section 29, township 26, range 15, and owned by George Hill. Geologically it is a part of a high escarpment caused by the vast stratum of massive sandstone which lies just beneath the Oread limestone that marks the upper boundary of the Lawrence shales, this escarpment being quite conspicuous for many miles both north and south of this place. To the east is a small creek called West Buffalo, heading some six miles northeast, Big Sandy being some miles to the west. Here we find in the place of the layer of massive sandstone a stratum of quartzite for almost one mile, extending along the brow of the escarpment, which runs here in an east and west direction. On top of the hill the surface is level for several miles looking to the northwest. Beneath this stratum of quartzite is approximately 150 feet of shale, and then appears a layer of blue limestone from two to three feet in thickness, very hard, of conchoidal fracture, and containing very few fossils, the paucity of which is very noticeable.

Some 300 yards south of the western limit of the quartzite layer the blue lime is found to be filled with vertical veins running in every direction, varying in thickness from something over one to a few inches, extending through the entire layer. They are apparently fissure-veins. The surrounding lime shows a very marked contrast in appearance to that of the vein stuff, and weathering greatly heightens this effect. Immediately above the lime the shale is very black and hard. Here and in the quartzite many

holes have been dug prospecting for silver in the boom days of the place, hence the name "Silver City."

Along east and south of Silver City ridges and mounds capped with sandstone are noticed, the valley being some two miles wide. In the tallest mound, two or three miles southeast, I found a thin layer of lime—probably that has only a local occurrence, since I failed to find it anywhere else.

It seems that there are two important layers of sandstone in the Lawrence shales from Silver City to the state line, and in the shale separating them a thin stratum of very blue, hard limestone is found which serves the purpose of easily locating the sandstone layer; the upper stratum of sandstone forming the escarpment in this formation; the under layer forming the many mounds in the eastern part of the Lawrence shales. The blue limestone was seen in many places, from two miles northeast of Yates Center to several miles west and south of Elk City, and without doubt is permanent within the boundary given. The extent north and south of these limits is undetermined, but I suspect that this lime is continuous in this position. A similar lime in the same position is found west of Ottawa.

The upper massive sandstone is from ten to thirty feet in thickness, and beneath this is a clayey shale. This, being softer than the sandstone above, is eroded faster, and therefore the escarpment is usually very rugged, the sandstone outcropping in cliffs often twenty to thirty feet in height, and in some instances more. Also, in many places massive boulders have tumbled down from the sandstone, thus making this formation very picturesque and the scenery very rugged and beautiful. This is especially noticeable where a spring, which is very common in this formation, appears in the soft clayey shale beneath the sandstone, or where a stream has eroded away the softer material and the firmer sandstone has slipped down the hillside as a great landslide or has gone down as massive boulders. In some places the sandstone from the erosion of the shale forms an overhanging wall, the so-called caves of this region. True caves are found only in limestone formations. Many springs are found flowing from the clayey shale beneath this massive sandstone. The water of these springs is of exceptional purity, as shown by many analyses in volume VII, Geological Survey Reports, and forms one of the attractive features of this section of the state. The "Delaware Springs" is a noted example. Wells dug in this region also furnish very excellent soft water. The explanation is very simple. The coarse sandstone being nearly pure

sand, cemented by oxid of iron, both of which are insoluble, therefore the water is practically as soft and pure as cistern water.

The soil formed from the decomposition of the sandstone formations gives a poor soil on the ridges for agricultural purposes, but is adapted to fruit-growing and some vegetables.

Both the sandy formations, but especially the upper one, are covered with a shrubby oak called "Black Jack." This often affords a means of seeing for miles the trend of the formation.

Many mounds are found, especially east of the upper sandstone escarpment. In these mounds, especially around Elk City and Niotaze, the sandstone which caps them is often found dipping and fractured in one direction for a few rods, and then in another—for example, the Oliver mound, two miles west of Elk City. In going from the valley to the top of this mound we pass first over shale, then over the blue limestone about fifty feet above the river bottom, then again shale, then the massive sandstone, which is found to be broken and dipping towards the hill. Here are found three benches, the sandstone capping each. Considerable quarrying has been done in each bench, and thus an opportunity is afforded for accurately observing the lay of the sandstone. In the highest part of the mound, that is, the highest bench, the sandstone was found to be horizontal, but in the others to be greatly disturbed. However, an examination showed that the blue limestone was undisturbed and on the same level in this mound as in the others in this vicinity, showing that the disturbed sandstone was local and caused by the soft, clayey shale underlying the sandstone pushing out and being eroded away, thus causing the massive slides in the hard sandstone above the shale.

Another example is the mound one mile north and west of Elk City. This mound has the appearance of a "hogback" from the river bottom. When going onto this mound at the lowest point we find a heavy layer of sandstone horizontal, capping a narrow ridge, say thirty feet wide. Going southeast for 300 yards to a point some twenty feet higher, we find the characteristic blue limestone on the same level as in the Oliver mound. The layer of sandstone five to ten feet thick is the sandstone found always under the blue lime. Going northeast, to the highest part of the mound, we find the sandstone dipping sometimes in one direction and then in the opposite. However, the blue lime was traced all around the mound and found to be undisturbed, save in a few places, where it was evidently covered by sandstone from above; or in some instances landslides have pushed the lime down the hill; but in all cases this

effect was evidently local. As seen, some of the quarries here show that the sandstone has slipped down because the sandstone layer gives out, leaving a facing of shale.

About four miles southeast of Elk City, across the river at the ford, the first mound reached, many layers of sandstone are found dipping forty degrees south, and on the south side of the mound we find the same strata dipping north at about the same angle, the mound running mostly east and west. Little quarrying has been done in this mound and the examinations were not so complete as in the others, but sufficient to make it clear that this did not differ from those described.

Many mounds are found near Niotaze, to the east, north and south. The most interesting one, geologically, is the one part of which is in the north end of the town of Niotaze.

This mound contains about 100 acres and is mostly owned by Mr. Dobbs. In this mound many quarries have been opened and a good opportunity is afforded for the study of the strata. It will be observed that the strata become more horizontal as one reaches the summit of the ridge. The ridges and mounds west, north and south of this mound contain a similar layer of sandstone and in exactly the same position, and at no greater change of level than the normal dip. It will be seen that the general dip is to the southwest. No strata of sandstone is found appearing anywhere save on top of the hills, and a careful inquiry after records of wells in the west part of town, which is in the valley between this mound and the next ridge, showed that no sandstone was reached.

Many mounds were examined, but the above description is a fair sample of all.

Streams sometimes flow along the base of this formation, thus giving on one side of the stream an entirely different soil from the other, and upon a superficial examination leading to an erroneous impression concerning the phenomena. An example of this is found at Elk City, where the Garnett lime is found east of Duck creek and the soil is calcareous, while west of the creek the soil is sandy from the sandstone in the mound and the sandstone escarpment. An examination of the wells on the west side of the creek showed that they reached the Garnett lime and that it had the normal dip to the west.

In no instance was any strata in any of these mounds found to have a dip greater than the general dip, but that a careful study of all the phenomena showed plainly that it was caused by a landslide facilitated by erosion or by cross-bedding.

DIPPING SANDSTONE.

The upper massive sandstone in the Lawrence shales is found to be dipping in many places. Generally the dip is toward the center of the range or away from the escarpment. Also, the dip is, wherever examined, greater in the lower layers of sandstone, beneath which is a soft clayey shale, than in the upper ones. A cross-section of this dipping sandstone is sometimes seen in quarries, but the best examples I saw of it were in a large quarry one and one-half miles northeast of Yates Center, and in quarries along the escarpment from Mr. Soward's, two miles up the river from Oak Valley, to a deep railroad cut two miles east of Longton. A description of the appearance in this cut will suffice for all.

The sandstone which is the upper one is found to be very much distorted in this cut. Upon entering it at the west end, we find at the north side the strata dipping forty degrees to the west, and a few feet farther dipping at the same angle to the east. On the south side the underlying shale appears as though pushed up and separating the sandstone, which dips the same as on the north side. Where the shale has pushed up into the sandstone the twisted and contorted structure was noticed, and also the dipping sandstone. This cut is 200 yards long and the shale is pushed up into the sandstone six times in this distance to a height of from four to six feet above the railroad track, and at each place the phenomena of the sandstone is similar. The extent of the sandstone below the road-bed was not determined. The appearance is that the sandstone is broken and the shale pushed up, while the massive sandstone has settled down into the shale. The cut is from thirty to forty feet deep and the layers of sandstone become more and more horizontal as the top layers are reached. However, this seems to be generally true of all the dipping strata.

I concluded that all the dipping sandstone is from cross-bedding, massive landslides, or an uneven surface upon which the sandstone was originally laid down, the Longton railroad cut being an example of the latter. The mounds are all caused by erosion.

The reddened sandstone is caused by the changing of the iron coloring agent from the ferrous to the ferric state. All the different strata were found to be in place. Some low anticlinal and synclinal folds were noticed. In the anticlinal folds the massive layer of sandstone is often broken and the sides of these fissures faulted from one to six inches, as may be seen in the sandstone quarry one and one-half miles north of Yates Center.

THE SKULL AND EXTREMITIES OF DIPLOCAULUS.

By S. W. WILLISTON, University of Chicago, Chicago, Ill.

IN 1877[1] Professor Cope described, from the reputed Permian of Texas, some small vertebræ as of a salamander-like reptile under the name *Diplocaulus salamandroides.* The type specimens, now in the possession of the University of Chicago, were later figured by Case.[2] In 1882 Cope[3] recognized the same genus from the Permian of Texas, and described more fully a species of a much larger size under the name *D. magnicornis*, which he now referred to the Microsauria and to the family Diplocaulidæ, which he had previously proposed in a catalogue of the Permian vertebrates as a member of the Pelycosauria.[4] He here describes for the first time the characteristic zygosphene. In 1895 Cope,[5] with better material of *D. magnicornis*, gave a more complete description, correctly figuring the upper surface of the skull and the anterior part of the palate. He also described here briefly a third species of the genus as *D. limbatus*, also from the Texas Permian, and characterized chiefly by the posterior concavity of the cranium and the greater protuberance of the quadratojugal posteriorly.

In 1902 Broili[6] published a preliminary description, with a rather poor figure, of the same species, giving for the first time the nearly complete structure of the palatal region. In the following year Jaekel[7] reproduced these figures and made some additional observations in a discussion of *Diceratosaurus.* Again, in 1904 Broili[8] published a more complete description of the same form, with additional figures, and referred the genus to a new family, the Diplocaulidæ, under the misapprehension that Cope's name, given in error of the real relationships of the animal, had become obsolete. In this latter paper Broili also described and named two additional species, *D. copei* and *D. pusillus*, the latter a very small species, and doubtfully, I think, belonging in this genus.

During the past year an expedition to the Permian of Texas from the University of Chicago secured a number of excellent specimens

1. Proc. Amer. Phil. Soc., 1877, p. 187.
2. Journal of Geology, 1900, p. 710, pl. I, ff. 16*a*–17*b*; pl. V, ff. 17*a*–17*d*.
3. Proc. Amer. Phil. Soc., 1882, p. 451.
4. American Naturalist, XV, 1881, p. 162.
5. Proc. Amer. Phil. Soc., 1895, p. 455, pl. IX.
6. Centralblatt f. Mineralogie.
7. Jahresbericht f. Mineralogie, 1903.
8. Paleontographica, LI, 1904, pl. IV, ff. 4–15; pl. V, ff. 1–4; *D. copei*, p. 21, pl. III, ff. 1, 2; *D. pusillus*, p. 24, pl. VI, ff. 1–4.

of *Diplocaulus* of what appear to be distinctly two species, together with a large quantity of more or less intermingled remains of two additional smaller species of the genus from the Permian bone-bed near Orlando, Okla. This material enables me to determine much that is new and of interest concerning this singular genus of paleozoic amphibians, not the least of which is the discovery of small but well-formed limbs, both anterior and posterior, which had been previously never detected in the abundant material known. There is yet much to be learned concerning the structure and especially the habits of these remarkable animals; so much that I do not venture to give a restoration of the creature. The figures, carefully drawn by myself, will render unnecessary a detailed description of the bones.

SKULL.

Two excellent skulls, both nearly complete, were obtained of two distinct forms. The better one of these two (No. 651) is perhaps the best of the genus hitherto obtained. It was found by myself lying exposed upon the top and side of a small mound, near the Wichita river, just west of the Vernon road in Texas. It was in two larger and two smaller pieces, the largest with its dorsal surface uppermost, from which the thin outer tablet of bone had been eroded by the weather, rendering the sutures for the most part very conspicuous. That I might not be biased by Cope's determinations of the sutures, I traced them quite independently, as they are reproduced in the drawings (figs. 1 and 4). A comparison with Cope's figures (reference to which will be found in the foot-note) will show how closely they agree throughout. Broili,[9] in his studies of the skull, was unable to distinguish the sutures, and even cast doubt upon Cope's determinations. With the aid of a hand lens I find no difficulty in distinguishing them in any specimen.

The figures will show sufficiently well the form and relations of the different elements to render unnecessary a detailed description of them. The absence of a distinct lachrymal bone is not at all remarkable, since other early forms either lack this element or have it excluded from the orbit; and these facts seem to support the contention of Jaekel that the element usually so-called is not really the lachrymal of the mammals, which should rather be homologized with the prefrontal, a very constant bone. The fusion of the postorbital and postfrontal is, however, unexpected. That

9. Paleontographica, LI. p. 8, 1904. He says, after an examination of the skull figured by Cope: "auf welchem samtliche Nahte eingetragen sind, so sind dieselben in Wirklichkeit auf dem Stucke zumeist nicht vorhanden, sondern mit Farbe eingezeichnet; an einzelnen Stellen durften ja Teile von Nahten existierin, dooh war es mir nich moglich infolge der eingetragenen Linien etwelche zu constatieren."

one or the other is absent in so many of the later reptiles may perhaps explain its absence here.

The maxilla presents but a very small surface on the superior aspect of the skull; on the side the suture separating it from the jugal turns backward obliquely, as shown in fig. 1, to the hind end of the dental series, passing inward obliquely to the palatines, separating apparently a transverse element, which is known to occur in other stegocephs. The parietal is very large, articulating posteriorly with the supraoccipital plates and the epiotics.

The "supraoccipitals" are clearly distinguished, both upon the upper and the under sides, articulating normally with the parietal, epiotics and exoccipitals. On the under side the suture separating them from the parietals passes inward so as to include the union with the exoccipitals. There seems to be little doubt but that these elements are real membrane bones, but they functionally subserve the same purpose as the unpaired supraoccipital of the higher animals, since there is no indication here of an intervening element between them and the occipitals. Most characteristic of the genus and family are the greatly enlarged "epiotics," produced, as they are, into such extraordinary horns. In the present species these horns are obliquely concave distally, almost spoon-like and somewhat dilated, very different from the conical termination of another skull from Texas which I must refer to *D. magnicornis*, as also from the horns of one of the small species from the Orlando bonebeds.

This modification of the extremity seems to imply a distinct functional use; very probably, as has been suggested, for the protection of the branchiæ. In the earlier amphibians the lateral cornua may be composed either of this element or of the prosquamosal (or supratemporal); in the the latter case the otic notch between the two. In reality, the same notch is found in *Diplocaulus* between the epiotic and the prosquamosal on the lateral aspect of the skull. As regards the homologies of the two elements called here the squamosal and prosquamosal there has been, as is well known, much contention. Cope called these bones in *Diplocaulus* the supramastoid and supratemporal. The more usual nomenclature is the squamosal and supratemporal, but indifferently applied. That they agree well in position and relations with the corresponding elements of the Microsauria is apparent, and I shall continue to call them, after Baur, the squamosal and prosquamosal until the problem of their homologies is more satisfactorily settled than is at present the case. The squamosal (SQ) is a small bone, articu-

lating with the parietal, jugal, postorbital and prosquamosal. The prosquamosal (PSQ), on the other hand, is a very large bone, articulating with the epiotic, parietal, squamosal and jugal above, the quadrate and the quadratojugal below; and these seem to be the relations of the other Permian air-breathers.

The quadratojugal, or "postquadrate bone," as Cope has sometimes called it, is in reality not at all postquadrate. It unites in front with the jugal above, behind with the prosquamosal and apparently with the proximal end of the quadrate. In most specimens by pressure it is turned inward so that its chief face lies horizontal; in life, however, it was evidently directed more downward, forming by its frontal free border the margin of the fossa into which the coronoid process of the mandible fitted. A view of the left side of the specimen under discussion is shown in figure 3, but I cannot be sure that the fossa and foramen are natural. On the opposite side the fossa is less evident. In figure 3 I give a cross-section of the side opposite to the one shown at a place corresponding to the arrow mark. There is a striking difference in the relations of the bone posteriorly in this specimen from those seen in another remarkably good specimen, which must be determined as of *D. magnicornis*, in the deep notch between the protuberant end of the quadratojugal and the prosquamosal above, the so-called epiotic notch of the earlier microsaurs. It was this character which Cope laid stress upon as distinguishing his species, *D. limbatus*. That the distal termination of the horn in this specimen is a specific character seems hardly to be doubted. For the present, therefore, I call the present specimen *D. limbatus*, though the concavity of the posterior margin of the skull is quite like that of specimens referred to *D. magnicornis*.

The structure of the palatal region in this specimen has been made out quite satisfactorily, save that most of the distinguishing sutures are uncertain. The shape and arrangement of the parts agree well in general with the figures given by Cope and Broili, and there is not much to add to their descriptions. The transverse bones are clearly separated by suture from the maxilla and palatines. The quadrate seems to be free from the quadratojugals save at the proximal end; it passes upward and backward, to be attached on the under side of the posterior part of the prosquamosal. The exoccipitals pass outward a little in advance of the condyles as a long, narrow process on each side, doubtless the confluent opisthotic as far as the epiotics, uniting, for the most part, with the parietals. Between these processes and the parietals and su-

praoccipitals above there is a small canal or foramen leading forward into the brain cavity. Near the proximal end of the process there is also a foramen, for the vagus.

The mandible is wholly concealed from view above, articulating posteriorly by an hour-glass-shaped concavity with the quadrate. A differentiation of its elements I have not yet been able to make out, though I have a half dozen or more specimens in good preservation before me. At the anterior end of the mandible there is a second row of five small teeth, parallel with the outer or marginal row and situated close to the inner border.

VERTEBRÆ.

	mm.
Length of atlas	20
Greatest expanse of same	32
Length of second vertebra	11
Expanse of transverse processes	46
Length of third vertebra	13
Expanse	48
Length of fourth vertebra	14
Expanse	50
Length of fifth vertebra	17
Expanse	48
Length of sixth vertebra	20
Expanse	48
Length of seventh vertebra	21
Expanse	46

The atlas and the second vertebra are occasionally coössified, and Cope has mentioned the fact. Usually, however, they are separate, as is evidenced by six well-preserved specimens of the atlas before me. The figures (1, 4), together with Cope's description, will suffice. The first ribs are borne upon the second vertebra, the so-called axis; they are rather short and distally expanded. The fourth or fifth ribs, however, are slender, elongate, gently curved and not at all expanded distally. The second vertebra is much shorter than the median dorsal ones, the third, fourth and fifth increasing in length, until the full length is attained in the sixth or seventh. The transverse processes are stout and long, directed somewhat obliquely backward, the upper one, or diapophysis, arising from the arch, the lower, or parapophysis, from the centrum. The specimens figured (figs. 1, 4) are shorter and more transverse. They do not seem to be mutilations, though such is possibly the case. The arches have no real spines — merely a low obtuse ridge, especially characterized by an oval or cordiform pit posteriorly; that of the second vertebra is very large, while that of the third is either small or wanting. The zygapophysial surfaces are broad

and flat and are nearly in a transverse line. The zygosphenes, a remarkable peculiarity characteristic of this genus, and in a lesser degree of *Crossotelos*, are well developed, though the surfaces are much smaller than the zygopophysial ones. The peculiar linear striations, quite characteristic of the genus, are visible on all parts of the vertebra, though less pronounced on the transverse processes.

EXTREMITIES.

It is somewhat remarkable that evidence of the appendicular skeleton has hitherto never been furnished by the numerous specimens of *Diplocaulus* which have come to light from Texas, Illinois and Oklahoma. It has, in consequence, generally been assumed that the creatures were legless and snake-like in shape and wholly adapted for aquatic life. Jaekel several years ago suggested the presence of limbs in *Diplocaulus*, because of the well-developed clavicular girdle, evidence of which was presented by Broili. That *Diplocaulus* did have limbs, both anterior and posterior ones, albeit reduced, is now abundantly demonstrated by the material collected the past season in Texas and Oklahoma for the University of Chicago. Among this material there are one complete coracoid, five humeri, seven femora, numerous ends of epipodial bones and four associated metapodials. The mesopodials were doubtless unossified.

It is a well-known fact that specimens of land vertebrates in the Texas Permian are apt to be more or less intermingled, and the association of limb bones, especially when isolated, is by no means positive proof that there was an anatomical association in life. When the fauna of the Texas beds is sufficiently well known to eliminate in large part the known from the unknown, the detection of such accidental intrusions will be a much easier matter than it is at present. Many specimens are found exposed and weathered and more or less broken; in the collection of such upon the slopes and in the gullies it may often happen that fragments from different horizons are found intermingled; in other cases bones of different individuals may actually be associated in the same matrix. In the present case the association of the limb bones with the various specimens is such as to convince the most skeptical of their anatomical relationships. The material of *Diplocaulus* at present in the University collections is as follows:

Specimen No. 610. Skull nearly complete—the nasal extremity, the extremities of the horns, and much of the palate missing; fourteen probably consecutive vertebræ, including the axis and

atlas; fragments of the clavicular girdle. E. C. Case, collector, Texas.

Specimen No. 650. Skull nearly complete; one dorsal vertebra; two posterior vertebræ; femur nearly complete and extremity of metapodial. Of large size, the femur the largest of the collection. P. C. Miller, collector, Texas.

Specimen No. 651. Twenty-five vertebræ from different parts of the column, but no cervicals. Right and left femora, several extremities of epipodials; four united metapodials. Of small size, the femora the smallest of the Texas specimens. P. C. Miller, collector, Texas.

Specimen No. 652. Complete skull; twenty vertebræ, mostly continuous from the skull, a few caudals, left coracoid attached in position to the upper side of the complete clavicular girdle, as figured; right and left humeri, the right one attached in position to the under side of the cranial horn opposite the fifth vertebra; distal extremity of femur. S. W. Williston, collector, Indian creek, near the Wichita, Texas.

In addition, large quantities of more or less broken bones belonging to at least two small species from the bone-bed near Orlando, Okla. Associated with this material, and in nearly every case in immediate connection with Diplocaulus vertebræ in the matrix, several humeri, femora and ends of epipodials; none of the limb bones matrically associated with bones of other forms.

The above evidence would seem sufficient to satisfy the most hypercritical. The remarkable fact is that nearly every specimen observed the past season presented evidence of the extremities. The limb bones, so far as known, indicate small extremities, relatively quite small in proportion to the skull, or even to the vertebræ; they could hardly have been of much use in terrestrial locomotion. That the anterior limbs were attached quite close to the head will be evident from the position of the humerus, as shown in figure 2; in this specimen the vertebræ were curved closely to the side of the horn, more so than is shown in the drawing.

A nearly complete coracoid was found imbedded on the upper, visceral side of the interclavicle, and is yet firmly attached to the bone. Its position is such, immediately back of the clavicle, with the articular surface for the humerus nearly flush with the left margin of the interclavicle, that there would seem to be no doubt of its natural position. It is a thin bone, nearly regularly oval in shape, save for the thickened emargination on the outer posterior part, for the reception of the humerus. A small foramen is visible on the

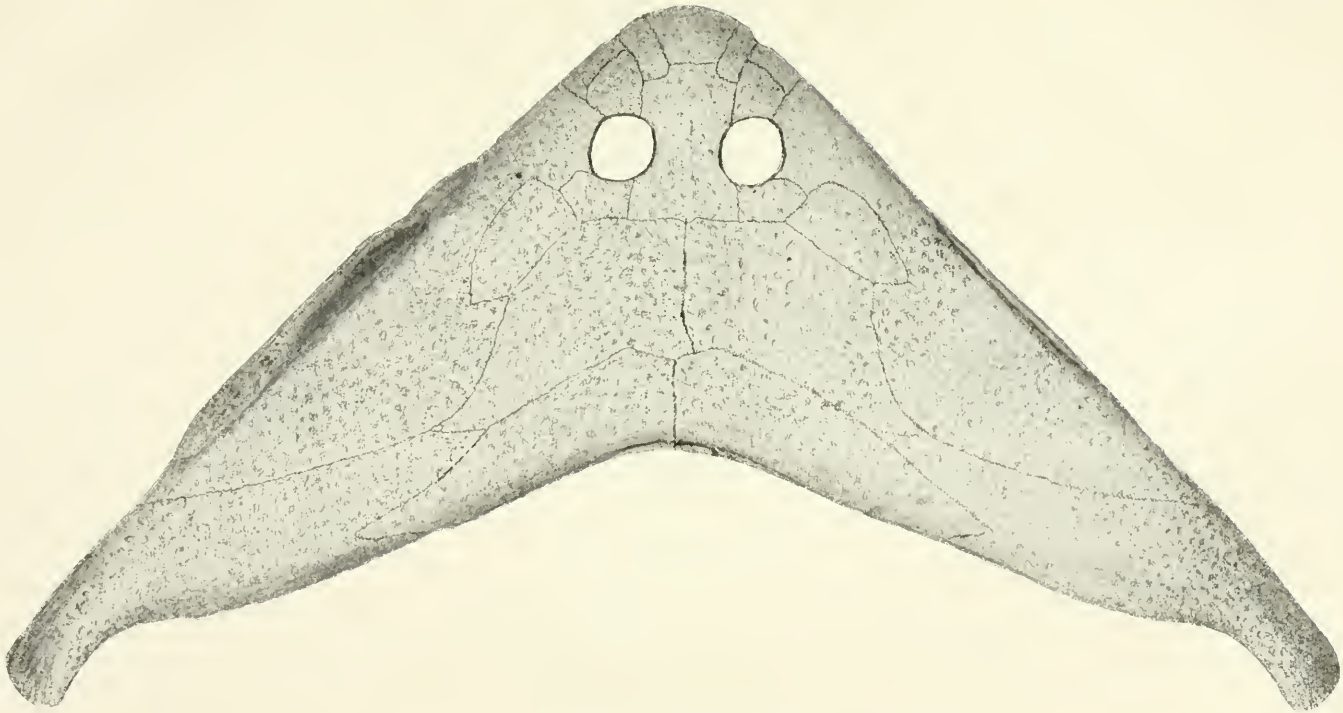


PLATE 1. DIPLOCAULUS SKULL. Superior aspect.

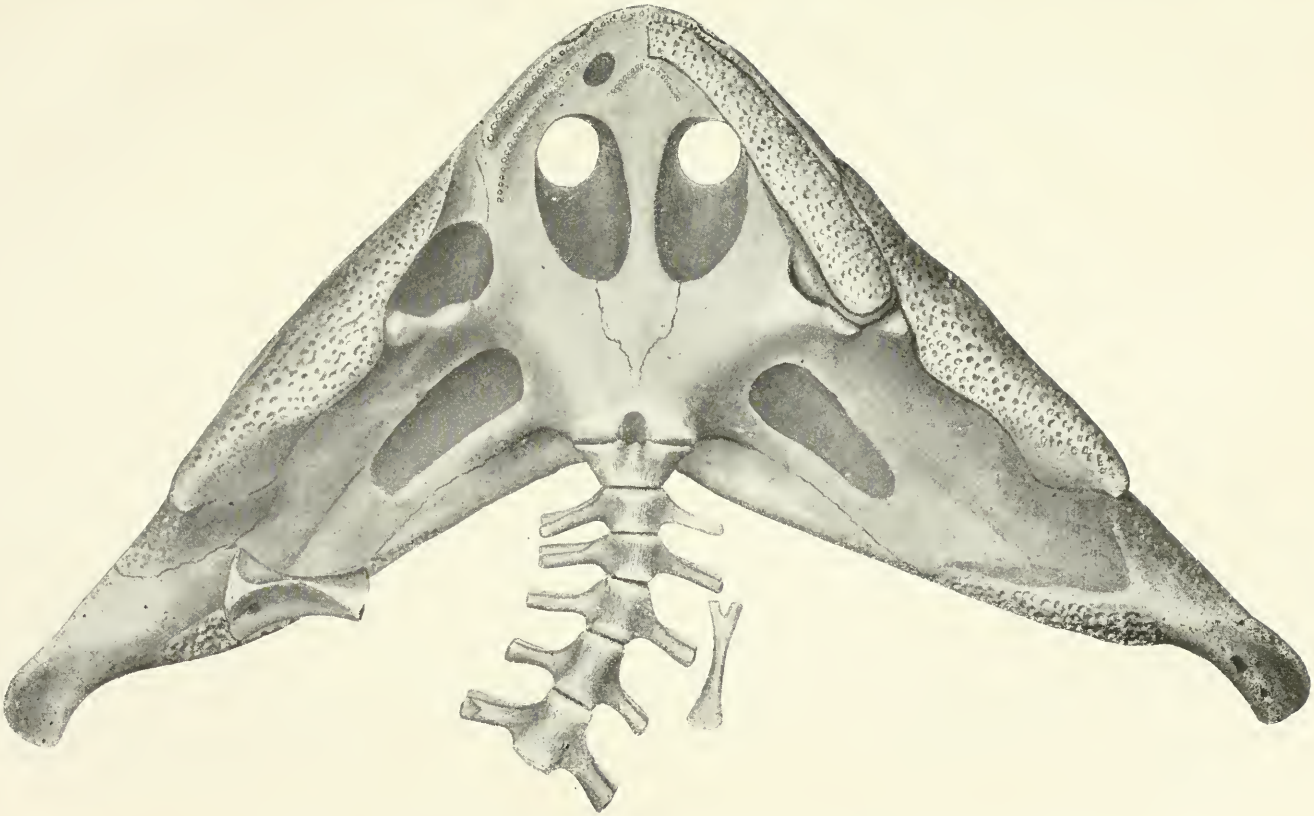


PLATE 2. DIPLOCAULUS SKULL. From below, with vertebræ and coracoid.

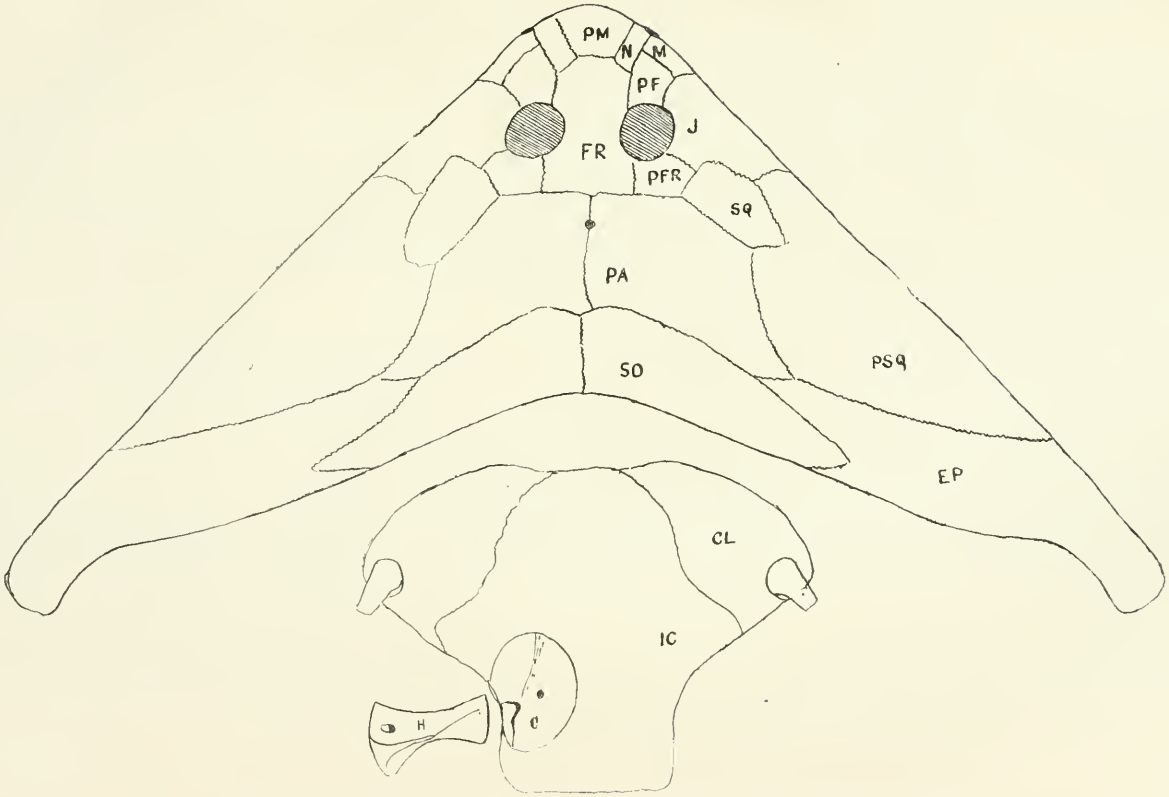


PLATE 1*a*. Sutures of skull. PLATE 4*a*. Clavicular girdle.

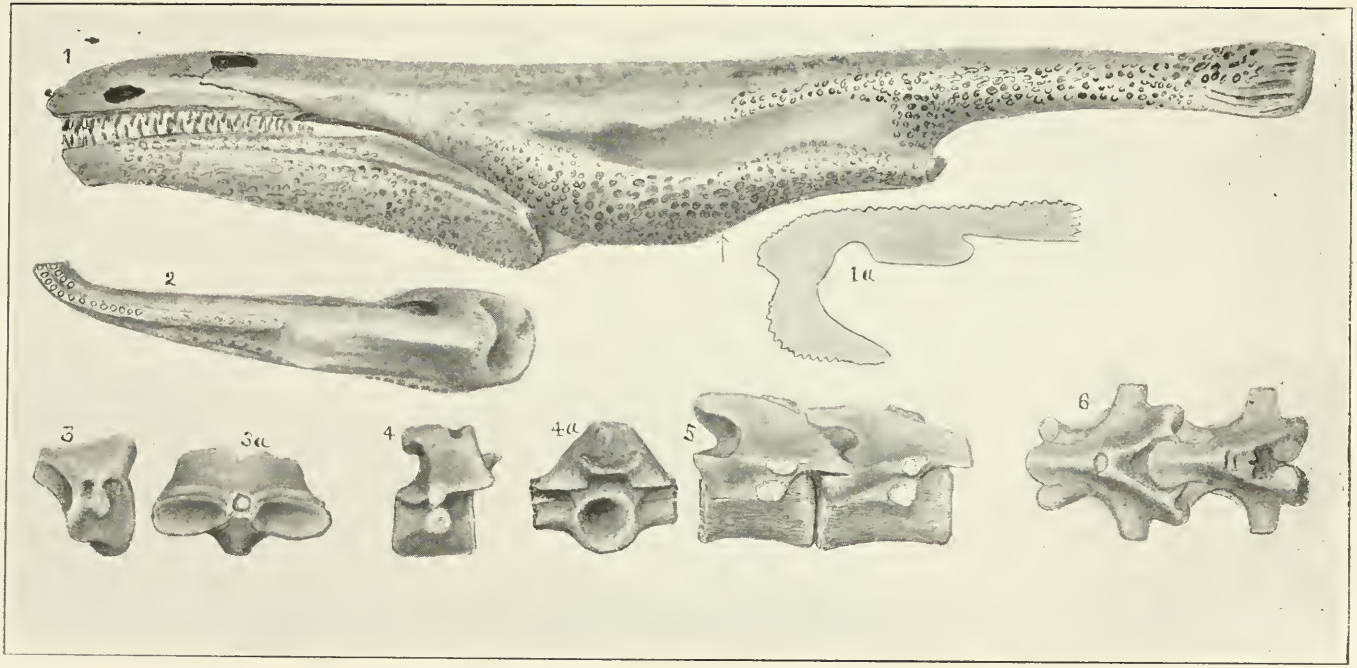


PLATE 3. DIPLOCAULUS. Side view, with small bones.

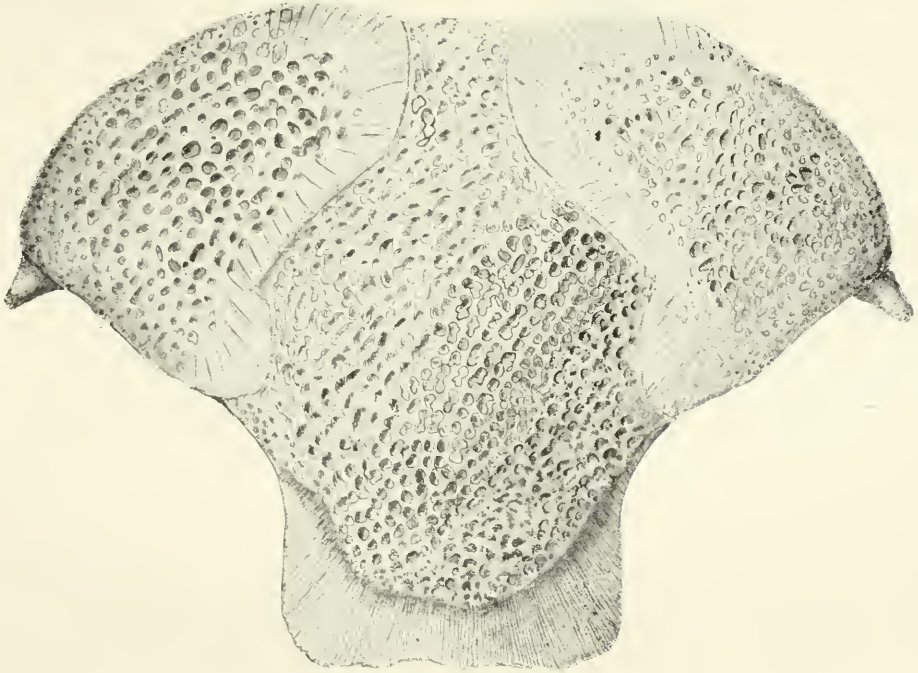


PLATE 4. DIPLOCAULUS. Clavicular girdle.

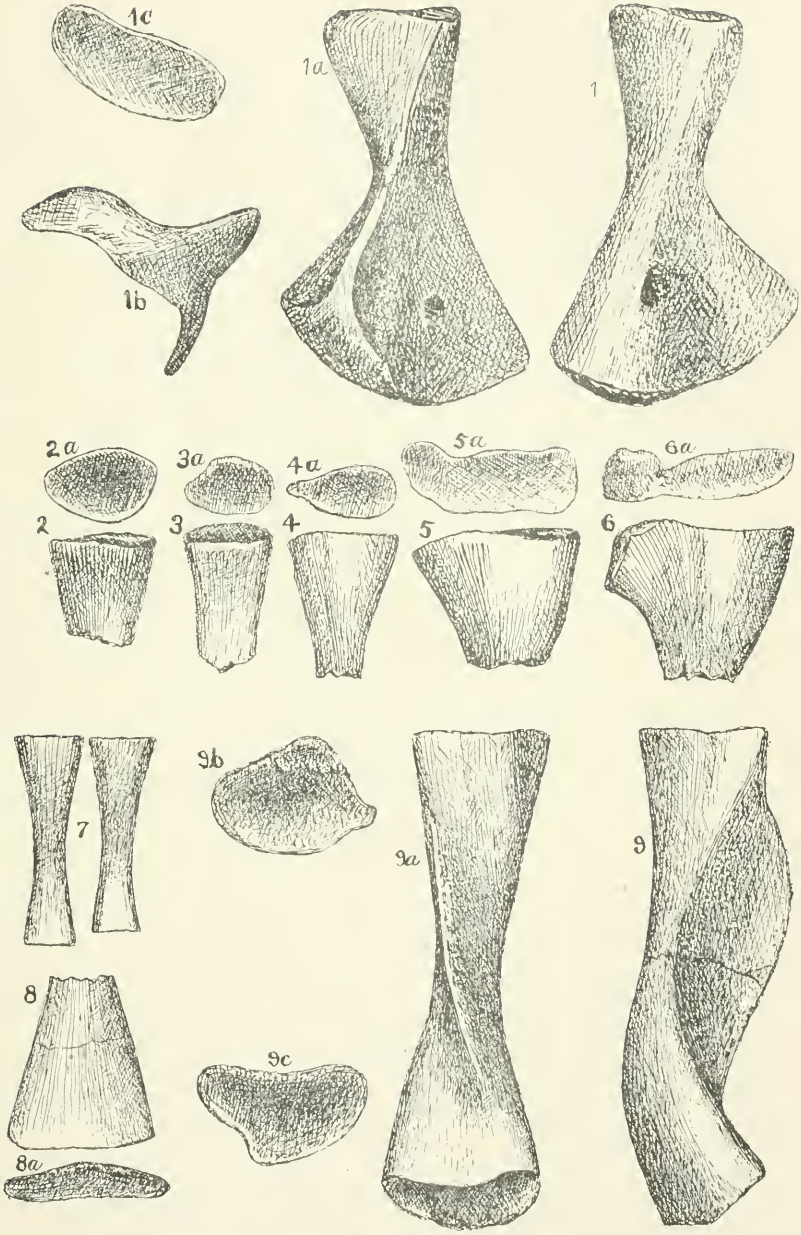


PLATE 5. DIPLOCAULUS. Limb bones.

FIG. 1. Humerus, dorsal view; 1*a*, the same, ventral view; 1*b*, proximal articulate; 1*d*, distal articulate.

FIGS. 2 to 6, epipodials; 2*a* to 6*a*, articulates.

FIG. 7. Metapodials; 8, 8*a*, epipodial; 9, femur, external view; 9*a*, posterior view; 9*b*, proximal articulate; 9*c*, distal articulate.

inner side back of the middle and not far from the margin. Because of this position and absence of any distinct sutures, I believe that the bone is the coracoid only, and that the scapula was a separately ossified bone. An outline of the bone in its relative size is shown in plate 2.

The clavicular girdle, found with its parts in nearly perfect relations, the outer side of the right clavicle only missing, is remarkable for its large size. The three bones together form a gently concave trough, nearly straight in the middle antero-posteriorly. All the bones show on their outer surface the characteristic pitting of the skull, with their margins thinned and delicately grooved radially. A stout process from the clavicle on each side is directed inward and upward, and somewhat backward, perhaps for attachment to the yet undiscovered scapula. A figure of the united bones from below is shown in plate 2; and the outline of the three with the attached coracoid in plate 4. The rather stout humerus has its two extremities twisted at an angle of about forty-five degrees. The proximal extremity (plate 3) is transversely expanded and of moderate thickness, without tuberosity of any kind; indeed until the discovery of the epicondylar foramen I was disposed to consider this the distal extremity, though rather puzzled to account for the transposition of the right humerus attached to the skull apparently in immediate connection with the pectoral girdle. The distal extremity has a much greater expansion and thickening. Distally and laterally there is a well-defined canal piercing the bone obliquely, evidence for which is corroborated in other specimens from Orlando. The presence of an epicondylar foramen has usually been considered as characteristic of the reptiles and wanting in the amphibians, though Cope expressly mentions such a foramen in *Acheloma*, a Texas temnospondyle. From the opposite side a narrow but high ridge ascends the bone obliquely about half way toward the opposite side, extending nearly to the extremity as an elevated ridge. The shape of the bone in different aspects will be well understood by reference to the figures made from a well-preserved specimen of small size from the Orlando beds.

Of the femora the best preserved is one from specimen No. 651; various others from Texas and Orlando agree well with it. The bone is much more slender than the humerus, with the proximal and distal expansions subequal and but moderate in extent. On the posterior side there is a high but thin oblique crest, occupying about three-fifths the length of the bone, and reaching neither ex-

tremity. The bone distally is curved strongly backward, so that its articular surface looks backward at an angle of about twenty degrees. So far I have found no complete epipodial bone, though doubtless a careful search of the Orlando material will reveal such. The extremities of a number of epipodials are shown in the figures (pl. 3). They are parts of the tibia and fibula. Associated with No. 651 are four metapodials attached and lying parallel, or nearly so, in the matrix. They are simple bones, as one would expect, with the shaft moderately constricted, the extremities truncate. It is very evident that the hind extremities were more slender than the anterior ones, and probably longer, preserving more of the terrestrial characters, and doubtless also of use upon land. Nevertheless their size, in comparison with that of the vertebræ, is small.

In none of the Texas material at command is there any evidence whatever of dermal ossifications, other than the clavicular gridle. Nor do I find any certain evidence of such from the Orlando material. Dermal plates are there in abundance in this material, but none intimately associated with *Diplocaulus* bones; whereas specimens of *Crossotelos*, another form which must for the present be located with *Diplocaulus* among the Microsauria, though aberrant, show abundant evidence of ventral ribs and probably also dermal scutes. All of which goes to show that *Diplocaulus* was a bare-skinned amphibian of predominantly aquatic habits, capable, however, of progression, doubtless with much labor, upon land. Its position among the Amphibia is not assured In the complete ossification of the vertebræ it has its nearest relationship among the Microsauria, the Lepospondyli of Zittel, in which group it was placed by Cope when he recognized the amphibian nature of the genus, and to which it has also been assigned by Broili and Jaekel. Furthermore, in the structure of the skull, notwithstanding its extraordinary shape, it offers no important differences from that group so far as is known; the epiotics are enormously developed, it is true, but the epiotic notch is still preserved on the side.

In the articulation of the ribs, however, there is a profound difference, one which seems to ally the type with the modern Urodeles, as Cope intimated in his early descriptions. The true microsaurians have single-headed ribs attached intercentrally, or at least the capitulum is always so attached—in *Diplocaulus* the elongated diapophyses arising from the arch, and the equally elongated parapophyses from the centrum near the middle anteroposteriorly. There is perhaps no more important ordinal character among the

early air-breathing vertebrates than the mode of attachment of the ribs. No such difference as *Diplocaulus* presents is found anywhere among the members of the reptilian orders.

I by no means wish to suggest that *Diplocaulus* should be separated from the microsaurians as a distinct order, but that that group is entitled to a higher rank than that of a family I do believe. Furthermore, as I have said, *Crossotelos*, so far as the vertebræ are concerned, must be associated with *Diplocaulus*. If I am correct, however, in my recognition of the skull of this genus, it is of a widely different type from that of *Diplocaulus;* and the limb bones also, so far as I have determined them, are very different. The genus indeed represents a distinct family from Diplocaulidæ—the Crossotelidæ, further details of which I shall give in a future paper.

SOME NOTES ON THE OLYMPIC PENINSULA, WASHINGTON.

By Albert B. Reagan, La Push, Wash.

INTRODUCTION AND ACKNOWLEDGMENTS.

THE field-work upon which this paper is based has been carried on as time would permit for the past four years, the most of the work being done during the summer months of each year. The type fossils collected are in the writer's collection at La Push, Wash.; duplicates are to be found in the geological collections of the Leland Stanford Junior University and in the museum of the Kansas Academy of Science.

The Olympic peninsula is a very difficult region in which to do geological research work. There are but two wagon roads in the entire area west of Mount Olympus. One of these roads, aggregating some forty miles in total length, connects Port Angeles with Lake Crescent and Port Crescent, and the latter again with Lake Crescent; the other road extends from East Clallam, on the Strait of Juan de Fuca, south to La Push, of the Pacific front, a distance of about fifty miles. Trails extend along the beach of both ocean and strait. Trails also extend from West Clallam to Ozette lake and the Dickey lake country, and from the latter on to Quillayute Prairie. Another trail connects Forks with the Hoh country. A few short trails also branch off from the main trails here and there. These afford all the means of gaining access to the interior, except by canoe on the various streams; for off of the trails and roads the fallen timber, underbrush and ferns make the forest such a jungle in most places that one cannot travel half a mile an hour.

Consequently the stratigraphical work in the interior has been more of a reconnaisance; also, as a result, the division lines between the formations indicated on the map are merely suggestive.

In submitting this paper I wish to state that Dr. James Perrin Smith, professor of palæontology in Leland Stanford University, has had general supervision of the classifying of the fossils hereinafter described, and has also reviewed the manuscript for me. I also wish here to thank Dr. John Casper Branner, of Leland Stanford University, for the aid rendered me by him.

PREVIOUS LITERATURE.

So far as the writer is able to learn, the literature directly concerned with the geology and natural aspects of this region is confined to six papers.

Mr. S. C. Gilman,[1] a civil engineer, visited the central mountainous part of this region in 1895, of which he gives a fairly accurate map and a good general description.

Messrs. Dodwell and Rixon,[2] while making an expert forestry examination of the Olympic forest reserve, added some notes of interest to the geologist concerning the region.

Mr. H. S. Conrad,[3] in his article on "The Olympic Peninsula, Washington," gives some geological observations on the southwestern coast of the peninsula which are of interest.

Mr. Ralph Arnold visited the region in June and July, 1904, and has since published papers on "Coal in Clallam County, Washington,"[4] "Gold Placers of the Northwestern Coast of Washington,"[5] and a "Geological Reconnaisance of the Coast of the Olympic Peninsula, Washington."[6]

Some observations on the geology of the islands off the coast of the peninsula are also included by Dr. W. L. Dawson in his article on "The Bird Colonies of the Olympiades."[7]

LOCATION.

The region here under consideration is in northwestern Washington. It covers an area of about 8000 square miles, or an area about the size of Rhode Island, Delaware and Connecticut combined. It extends approximately 100 miles in a north and south

1. S. C. Gilman: The Olympic Country. National Geographic Magazine, vol. 7, 1896, pp. 133-140, pl. 16.

2. Arthur Dodwell and Theodore F. Rixon: Forest Conditions in the Olympic Forest Reserve, Washington. Professional paper, U. S. Geol. Surv., No. 7, 110 pages, 20 plates, 1 map, 1902.

3. Science, N. S., vol. 21, No. 532, March 10, 1905, pp. 392-393.

4. Contributions to Economic Geology for 1904. Bulletin No. 260, U. S. Geol. Surv., 1905, pp. 413-421.

5. Ibid, pp. 154-157, fig. 11.

6. Bulletin of the Geological Society of America, vol. 17, pp. 451-468, pls. 55-58.

7. The Auk, vol. XXV, pp. 153-166, 1908.

direction and 80 miles in an east and west line. It is bounded on the north by the Strait of Juan de Fuca, on the east by Puget Sound, on the south by Chehalis river and Gray's Harbor, and on the west by the Pacific Ocean. Port Townsend is at the northeast corner and Cape Flattery at the northwest, and the snow-capped Olympics occupy the central area. The region consists generally of a benched area along the coast from which the foot-hills gradually ascend toward Mount Olympus, 8150 feet in height, and the watershed between the Strait of Fuca and the Pacific, a high ridge which extends from the central mountain area to Cape Flattery. It embraces the whole of Jefferson and Clallam and portions of Mason and Chehalis counties. Port Townsend, Port Angeles, Neah Bay, and Cape Flattery on the strait, and Quillayute (La Push) and Gray's Harbor on the Pacific, are its most commonly heard of places.

HISTORY.

The railroad activity in northwestern Washington has brought before the public eye the Olympic peninsula with its giant timber and fertile valleys and prairies.

The region was first discovered by the Spaniards. In 1775 Bruno Heceta, a Spanish captain, landed on the coast a little south of the mouth of the Hoh river, planted the cross and took formal possession of the country for Spain. Then at the foot of the cross he had thus set up he buried a bottle sealed with wax, in which was written the record of his work and the statement that he took possession of the land for the crown of Spain. While he was thus in the official act of taking possession of the country, the Indians visited his ship, the "Sonora," under the lee of Destruction island, in charge of Heceta's companion, Bodega y Quadra. The Indians came in their canoes, held up bits of copper and iron, and with friendly signs sought to trade for more of the metals precious to them. Believing that everything was well, Quadra sent seven men ashore to trade with the Indians for wood and water. No sooner had they landed than 300 Indians rushed from ambush, killed the sailors, and tore the boat to pieces for the metal fastenings. Quadra was furious and wished to land thirty men to obtain revenge, but Heceta overruled him and sailed away, naming the island "Isla de Dolores," Isle of Sorrows. Later, in July, 1787, Captain Barclay, an English explorer, had a similar encounter with these same Indians, in which he lost six men. He named the river of Hoh "Destruction river" as a result of this encounter, but late geographers have restored the Indian name "Hoh" to the

river, but retain the name "Destruction" for the island that Quadra named "Isla de Dolores."

On August 1, 1790, Alferez Quimper, having been sent to explore the Strait of Juan de Fuca by the Spanish Captain Elisa, discovered Neah Bay and Bahada Point, two miles further east. The former he named Bahia de Nunez Gaona. And in May, 1792, Lieut. Salvador Fidalgo established a military post at the place, with necessary buildings and fortifications, and remained there until September. The bricks of the old fort—bricks imported from Mexico in the "Princessa," can be found in the earth banks there to-day. Here the Spaniards came in contact with the British, under Vancouver. A conference was called, and Quadra failed to agree with the latter. Then the two commissioners agreed to send to their home governments for further instructions, as a result of which the Spaniards were compelled to abandon the country.

While Vancouver was maneuvering with Quadra for the possession of the North Pacific, our own Captain Gray was making his famous trip up the coast, staying the winter of 1791–'92 at the harbor that bears his name. As a result of his trip, and that of Lewis and Clark to the Columbia later, the country was jointly occupied by the British and the United States till the treaty of 1846 gave the Oregon territory to the United States. And later, in 1855–'59, Governor Stevens's treaties settled the Indian troubles. But actual settlement in the region did not begin till a later date, and at no time have there been many white people living in the region back of the Olympics except along the Strait of Fuca and in the few scattered prairies.

INDIANS OF THE REGION.

The explorers found a tribe of Indians occupying the valley of each stream that flowed out into the ocean or strait; the village of of the tribe being at the mouth of the respective stream. In addition, the Makahs occupied the Cape Flattery section of the peninsula and the Chemicums the Port Townsend division. The Indians lived principally by fishing, though they also hunted. They represented different linguistic stocks and were continually at war with each other. The wars were carried on principally for the purpose of capturing slaves. Besides the slaves, who were almost always cruelly treated, the people of each tribe were divided into the chieftain stock and the base people. The former owned the land and received the greater part of the benefits of the hunting expeditions and of the fish and whale catches. In fact the base people were considered only a little better than slaves.

These Indians are short and heavy set and resemble the Japanese very much in facial appearance. When discovered they had plural wives, the chief having the larger number of women. Marriage was a loose affair, from our standard. And it is not likely that Sodom and Gomorrah could have put them to shame so far as virtue was and is concerned. These simple-hearted people are worshipers of nature and of two imaginary beings—Duskia, a giantess, and Kwatte, the creator. Duskia represented evil; Kwatte the good. Duskia went about capturing and eating little children; Kwatte cleared the sea of the great sea-monsters that killed the fish and even came up on the land and swallowed up whole villages of people. At last good overcame evil: Kwatte killed Duskia. The Indians now confound Kwatte with Jesus Christ, calling him Jesus Man. At the present time the Indians have a religion of their own manufacture. It is a combination of the old worship and Christianity. They have a cross and candles. They self-hypnotize themselves. Then all shake, tremble, muscle-quiver, and stamp by the hour, as they chant the monotonous song: "Hi, hi, hi." By this they expect to gain entrance into heaven.

SCENERY.

The scenery of this region is grand. In the lowlands one sees and is engulfed in stately timber. And at the ocean beach one beholds nature in all its beauty. To ascend one of the numerous islands along the coast, say James island, at an elevation of 150 feet above the sea, on a still day, and look southward, one may discern the dim outlines of Destruction island with its precipitous coast and dangerous reefs; also the low sandy beach and rugged rocks of the mainland shore-line, which extends as far as the eye can reach; and added to the view is an almost impenetrable evergreen forest which covers the entire coast; while here and there can be seen curling upward from some settler's cabin a column of blue smoke. To the east one sees the white-robed, snow-capped Olympic mountains. To the west the whale and the salmon jump and play at the surface of the gently waving waters; and the ships of the world pass in sight to and fro. To ascend the elevated areas toward the Olympics the view broadens and becomes yet more sublime, while open, flower-bedded areas gradually take the place of the forest. From Mount Olympus to the east, across the busy "Sound region," there stand out boldly against the sky Mounts Rainier and Baker, while high mountains close in the horizon from the land of the Norman Lion on the north to where the waves have turned to stone on the south. To the west, beyond the

wide expanse of green, the waters of the Pacific reflect the blazing rays of the setting sun. On every side everything is bathed in the most delicate tints and lies death-like in the evening haze, which seems to magnify them rather than subdue them.

VEGETATION.

The vegetation of the region is truly remarkable. Below 5000 feet is the great northwestern forest, which must be seen to be appreciated. Douglas fir, tide-land spruce and red cedar reach gigantic proportions. The available timber per township averages from 3000 feet (B M.) amid the high mountains up to 59,000 feet (B. M.) in the Quillayute region (Dodwell and Rixon). Below 2000 feet the region is a jungle. Taken as a whole it is the most heavily forested region in the country. There are estimated to be seventy billion feet (B. M.), in round numbers, or enough timber to supply the entire demand of the United States for two years.

The timber by species is as follows: Red fir, 24 per cent.; cedar, 10 per cent.; hemlock, 42 per cent.; spruce, 6 per cent.; Lovely fir, 18 per cent.

The principal trees and plants of the region are red elder, salal, *Shallon*, *Rubes*, *Ribes*, *Vaccinum*, Selaginella (*S. oregana*), bearded lichens, *usnea*, crab-apple, bearberry, dogwood (*Cornus nuttallii*).

Red fir (*Pseudotsuga taxifolia*): The principal forest-tree of the region west of the Olympics, it reaches its greatest development in the Quillayute country. It is seldom seen at elevations exceeding 3000 feet or near the seashore.

Lovely fir (*Abies amabilis*): A tall, silvery-barked tree found on the mountain slopes above 1500 feet.

Subalpine fir (*Abies lasiocarpa*): A tree found only near timber-line.

Red cedar (*Thuja plicata*): A tree growing in low and swampy lands. It is one of the principal forest-trees of the coast region.

Alaska cedar (*Chamaecyparis nootkatensis*): Found only on the mountain ridges.

Sitka spruce (*Picea sitchensis*): Found only in the vicinity of the Pacific coast.

Mertens hemlock (*Tsuga mertensiana*): A component of the forest everywhere up to timber-line.

Vine maple (*Acer circinatum*): A very common vine-like tree at altitudes below 2200 feet.

Maple (*Acer macrophyllum*): Found only on the bottom-lands. It makes a pretty shade-tree, and is used in making furniture.

Alder (*Alnus oregona*): Found along streams. The region where it grows makes good farm land when cleared. Alder makes the best wood, when dried, the peninsula can afford.

GAME.

In this region is to be found an abundance of game. Deer and elk are plentiful; wildcats, panthers and black bears are numerous; ducks and pheasants stay throughout the year, and the islands of the coast swarm with sea fowl; and the finest salmon and trout on the coast abound in the numerous streams.

CLIMATE.

The climate of this region is controlled by the prevailing westerly winds from the Pacific ocean, and is characterized by uniformity of temperature and by a heavy rainfall, the average being about 120 inches annually at Neah bay. Below 1000 feet elevation there is but little frost in winter, and snow is an exception. On the Pacific front ice is an almost unknown occurrence, while flowers bloom the year round and the grass keeps constantly green. The atmosphere is healthful, and the people are sturdy and strong.

SOIL.

The lower bottoms where alders grow are sandy; the bench bottom-lands are clay loam, but yield readily to cultivation. The soil of the swamps is a dark, porous vegetable mold from one to two feet in depth. This is underlaid with a substratum of blue clay, through which the surface-water cannot readily permeate. The hemlock uplands comprise about half of the general area, and where tested they have proven to be fairly productive. An analysis of the upland soil by Elton Fulmer, of the Washington State Agricultural College, gives the following:[8]

Unsoluble silica	54 8952
Hydrated silica	6 2524
Soluble	2527
Iron oxid	5 3950
Phosphoric acid	.0895
Chlorin	.1026
Allumesia	8.3865
Lime	2165
Magnesia	.2125
Potash	.0537
Soda	.4577
Sulfuric acid	1479
Volatile and organic matter	14 9733
Moisture at 120	8 3567

8. The Leader, Beaver, Wash., December 25, 1896.

This analysis shows that the uplands are well adapted to farming and fruit-raising, and the settler has demonstrated it to be a fact.

The soil of the prairies is composed of decayed fern roots, ranging from one to three feet in thickness, the soil thus formed being a black loam. So far as the writer knows it has never been analyzed; but its richness is demonstrated by the large crops that the prairies annually produce.

In this region there is no such thing as a crop failure. Hay, oats, wheat, rye, potatoes, carrots, and rutabagas do well, and in the lower areas grass grows throughout the year. Dairying and stock-raising are the leading industries, though lumbering is largely carried on in the strait section.

HYDROGRAPHY.

Rivers.

The rivers have a radial arrangement, extending outward from the central mountain area somewhat like the spokes of a wagon-wheel. The watercourses on the sound and strait sides are short and torrent streams. Those on the Pacific front are much longer and larger. All of them will make fairly good logging streams and are also capable of being harnessed to run mills and electric plants. It is not unlikely, when the fall and volume of these streams are considered, that as much water-power can be developed in this region as in Maine and Rhode Island combined. The principal streams of the peninsula are: Dungeness, Elwah, Lyre, Pysht, Clallam and Hoko on the Strait of Fuca; and Ozette, Queets, Raft and Quillayute and its tributaries, Soleduck, Calawa, Bogachiel and Dickey on the Pacific front. Four of these streams—Dungeness, Elwa, Soleduck, and Calawa, have been officially measured, respectively, at Dungeness, at MacDonald, near Forks, and near Quillayute, with the results indicated in the following tables.[9]

The Elwah river rises in the Happy lake country, north of the central mountain area, and flows nearly north in direction to the Strait of Fuca. Throughout its course, except a very few miles of its length near its mouth, its fall is great. It is worthy of special mention here, from the fact that it is said to have cut its channel through granite walls in its upper middle course; this being the only granite so far mentioned in the region. This watercourse is also worthy of notice, from the fact that the upper Soleduck, or some other river flowing from the south crossing the present Soleduck, was once a tributary of this stream. This channel is now

9. U. S. Geol. Survey, An. Rep. 1900-1901, pt. IV, Hydrography, pp. 457-461.

ESTIMATED MONTHLY DISCHARGE OF DUNGENESS RIVER AT DUNGENESS, WASH.

[Drainage area, 145 square miles.]

Month, 1900.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth, inches.
January	1,144	392	667	41,012	4.60	5.30
February	392	280	306	16,994	2 11	2.19
March	3,784	235	866	53,248	5.98	6.89
April	1,336	392	667	39,689	4.60	5.13
May	1,024	430	678	41,689	4.68	5.39
June	1,912	568	918	54,625	6.33	7.06
July	808	520	611	37,569	4.21	4.85
August	544	268	359	22,074	2.48	2.86
September	280	218	244	14,519	1.68	1.87
October	568	213	311	19,123	2.14	2.47
November	496	235	281	16,721	1.94	2.17
December	3,928	373	1,194	73,416	8.23	9.49
The year	3,928	213	592	430,679	4.08	55.67

ESTIMATED MONTHLY DISCHARGE OF THE ELWAH RIVER AT McDONALD, WASH.

[Drainage area, 188 square miles.]

Month, 1900.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth, inches.
January	6,945	1,025	2,518	154,826	13.39	15.44
February	1,566	690	920	51,094	4.89	5.09
March	14,198	710	2,849	175,178	15.15	17.46
April	6,945	930	1,744	103,775	9.28	10.35
May	2,951	1,100	1,918	117,933	10 20	11.76
June	8,738	1,260	2,789	165,957	14.83	16.55
July	1,892	810	1,253	77,044	6 67	7.69
August	1,310	650	941	57,860	5.01	5.77
September	1,138	562	672	39,987	3.57	3.99
October	6,315	495	1,327	81,594	7.06	8.14
November	4,907	930	1,649	98,122	8.77	9.79
December	12,242	1,566	4,171	256 465	22.19	25.58
The year	14,198	495	1,896	1,379,835	10 08	137.61

ESTIMATED MONTHLY DISCHARGE OF THE CALAWA RIVER NEAR FORKS, WASH.

[Drainage area, 213 square miles.]

Month, 1900.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth, inches.
January	8,000	850	2,943	180,958	13.82	15.94
February	4,950	777	1,738	96,523	8.16	8.49
March	12,600	655	2,400	147,570	11.27	12.99
April	2,475	237	762	45,342	3.58	4.00
May	2,070	225	685	42,119	3.22	3.71
June	6,600	330	1,128	67,121	5.30	5.91
July	687	190	460	28,284	2.16	2.49
August	507	110	169	10,391	0 79	0.91
September	347	60	130	7.736	0.61	0.68
October	7,800	60	1,804	110,924	8.47	9.76
November	11,600	777	2,307	137,276	10.83	12.09
December	8,100	1,160	3,111	191,288	14.61	16.84
The year	11,600	60	1,470	1,065,532	6.90	93.81

ESTIMATED MONTHLY DISCHARGE OF SOLEDUCK RIVER NEAR QUILLAYUTE, WASH.

[Drainage area, 272 square miles.]

Month, 1900.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth, inches.
January	5,560	1,180	2,567	159,683	9.55	11.01
February	2,860	1,090	1,398	77,641	5.14	5.35
March	12,580	1,045	2,663	163,742	9.79	11.29
December, 22 to 31	.....	.....	4,419	87,650	16.25	6.04

blocked, but continuous from the Soleduck at Wineton through Crescent and Southerland lakes and Indian creek to the Elwah. The raising of the land of the peninsula on the side next the Strait of Juan de Fuca dammed the stream, thus causing the lakes and the wind gaps. Glaciation has also aided in this lake forming, as we shall see later. The Elwah has quite a delta at its mouth.

The Lyre river is the outlet of Lake Crescent. It has a great fall throughout its entire course, except just where it enters the Strait of Fuca. There it is forming a delta. Its course is along a fault. It seems to be a very young stream, the lake having its outlet formerly at its northeastern terminus by the way of Lake Southerland to the Elwah river.

Pysht river follows a fault a part of its course; the remainder of its course is through a broad synclinal trough. It rises on the divide between the Pacific and the Strait of Fuca near where the Clallam-La Push road crosses that mountain ridge and flows into Pysht bay of the Strait of Fuca. It has a very low lower course running back from the coast several miles, it having filled a bay here in recent times; and at the present time its silt is filling up the bay at its mouth at a very rapid rate, so that the bay is now a mud-flat at low tide. In the early days the town of Pysht on this bay was quite flourishing, but the filling of the bay became such a hindrance to navigation that the place was abandoned and East Clallam was made the depot for traffic with the interior region, though it has a much poorer natural road outlet into the interior region. The Pysht river flat is a fine farming section.

Clallam river rises in the highlands back of Clallam bay; flows to the east and then to the north, entering the east side of Clallam bay at East Clallam, following a fault line a considerable part of its course. It carries considerable silt. It is diked in its lower course so that it runs northward along the beach wall of the east side of the bay nearly to Slip Point, a distance of about three-

fourths of a mile; this preventing it from being a hindrance to navigation.

Hoko river deserves notice from the fact that it rises on the south side of Clallam peak, makes a curve to the westward, turns northward, crosses the main divide between the Pacific and the Strait of Fuca, and enters the latter. It has kept pace with the rate of elevation and has maintained its channel. Its head waters are really in the Dickey-Quillayute valley, though by cutting a deep cañon through the ridge it has maintained its northerly course. This stream occupied its present position in Pliocene times, except that it flowed farther to the north in its lower course. It was this stream, aided probably by the Clallam river, that filled up the Clallam bay of that age. It is near base-level in its lower course; and its cañon serves as a pass from the Clallam bay region to the Quillayute country, via West Clallam.

The Sekiu is the last stream of any size that flows into the Strait of Fuca. In its lower course it cuts through fossiliferous beds of Miocene age.

Waatch river, on the Pacific side, is the first stream of any size south of the Cape. It is the remains of an abandoned strait that connected Neah bay with the ocean until even late Pleistocene times. It is now a mud-flat, its waters rising and falling with the tide.

The Tsoos (Sulz) river is a mud-tide flat in its lower course. It has a wide valley which joins the valley flat of the Waatch, the combined area being the farm lands of the Makah Indians.

Ozette river flows from the southwest corner of Ozette lake to the ocean through a very swampy area. It is a short stream without high banks and wholly cut in the Pleistocene deposits. It is of slow current, and fresh-water clams dot its bed. There is some talk of a ship canal being cut into this lake via this stream.

Quillayute river is formed by the union of the Soleduck and Bogachiel rivers about six miles from the ocean as the river runs. About a mile from the ocean it receives the Dickey river as a tributary from the northwest. It runs through a wide valley, most of which is material that has been deposited by the stream itself. A large bay has been filled up by this stream in comparatively recent times. It is a very changeable stream, and always carries great quantities of silt at flood times. Twenty-six years ago it entered Quillayute bay near the site of the Indian teacher's residence in the town of La Push, forming a large mud-flat at its mouth; but now it has cut its channel into the foaming surf three-fourths of a

mile further up-stream. It now meets the incoming tide and is forming no delta, but a bar out at sea is seen to be forming. The muddied waters of the river color the ocean a mile from shore at flood time. The abandoned channel of the river at La Push is known as the "lagoon," and is the playground and highway of the village. Its connection with the ocean is closed, but it is still an arm of the river and its waters rise and fall with the tide. The Quillayute and its tributaries drain the greater part of the syncline that extends from the coast to the top of the divide between the Strait of Fuca and the Pacific and from the Happy lake country in the Olympics to Waatch strait, the Ozette lake and river occupying the western part of this same trough. It is a young stream. It is likely not older than the late Pleistocene, though its tributaries are much older, a bay having occupied its site till then. The tide extends up this stream between four and five miles. A rapids at its mouth prevents it from being navigable.

Dickey river, the western branch of the Quillayute, drains Dickey lake, and was likely once the outlet of Ozette lake, if the Quillayute did not itself flow through a part of it and Ozette lake to the sea. It is near base level throughout almost its entire course, has very low banks, and is dammed in its lower course with log jams. Its course, for the most part, is through Pleistocene deposits, and the country through which it runs is low and practically level. Its northern branch, however, has its channel incised in cemented rock, it rising near Clallam peak. At a couple of places on this stream water-power can be developed.

Soleduck river, the northern branch of the Quillayute from the east, rises near the Happy lake country and flows westward along and at the foot of the western extension of the Olympics to near Beaver, where it makes a bold bend to the southwest, which course it continues till it mingles its waters with those of the Bogachiel to form the master stream. In its upper course it is an old stream. In Pliocene times it flowed into a bay that then extended far up the Quillayute trough. In the late Pliocene it likely joined the other streams of the region and reached the sea beyond the present shore-line. Then in Pleistocene times it again flowed into an arm of the ocean that extended as far inland as Tyee, recent sea-shells being found embedded in the clays at this place. The lower channels of the respective streams of the Quillayute country were drowned at this time. This stream is capable of great power development. About two miles above the Sulphur Springs, in the Olympics, south of Port Angeles, there is a waterfall capable of

developing 10,000 horse-power, which is to be developed in the near future for the purpose of running an electric road from Port Angeles via Crescent lake to the springs, and for lighting purposes along the line and at Port Angeles also. Besides the falls, the river has several rapids that may be utilized.

Calawa river, or Middle river, as the Indian word signifies, rises in the broken central region between the Soleduck and the Bogachiel and flows almost westward, pouring its waters into the Bogachiel a few miles above the latter's confluence with the Soleduck. In its lower course it is a meandering stream, though its channel is considerably incised. Once it entered the Bogachiel many miles above its present mouth, its abandoned channel now being Forks Prairie. A meander in it now is nearing the Soleduck, which stream will likely capture it in the near future of geologic time. Like the Soleduck, this stream has aided in filling up a bay in its lower course. In its upper course it is enclosed within cañon walls.

Bogachiel river, or Big river, as the Indian name signifies, rises within a mile of the head waters of the main branch of the Soleduck and takes a southwesterly direction, its course trending the southern rim of the synclinal trough. It soon encloses itself within cañon walls. Six miles from its course, as a bird flies, its bed is 2000 feet below the top of the surrounding ridges. In some places its inner valley is a half-mile or more in width; in other places it is "boxed up," and is further rendered impassable by rapids occuring in the river at these places. In the open spaces deer and elk feed. Reaching its middle course the stream turns westward, then west-northwest, and continues in that direction till it forms its confluence with the Soleduck. It is a very crooked stream, and is larger than the Soleduck and Calawa combined. In the rock walls of its cañon, in its middle course, there are exposed several seams of coal. In its lower course it has incised its channel in fossiliferous Pliocene rocks. It has several falls and is capable of great water-power development.

Hoh river has its head waters in the high ridges on the east side of Mount Olympus. From its source in makes a detour to the northward around the main mass of the Olympics in an almost semicircular course, then flows in a westerly direction to the Pacific, entering it in the vicinity of Destruction island, some eighteen miles down the coast from La Push. Into this stream drain the glaciers of Mounts Olympus, Meany and Constance; and the powdered sediment gives the water of the stream a milky color even at its mouth, forty miles from the mountains; a cup of water

let settle has sediment in it that indicates that the mountain mass is mostly slates and schists, the former predominating. The river is large and will admit small schooners to enter it at high tide or at high-water times. Its course seems to be along a great fault, it trending the southern rim of the Quillayute synclinal trough, but on the outside, down-throw side of the uplift. In its lower course it runs through a wide, flat valley. In its middle course it cuts through a glacial bench, a benched area indicating that a halt was made by the Olympic glacier at this place as it was retreating to its mountain home at the close of glacial times. In its upper course the river is enclosed in almost impassable cañon walls 2000 to 3000 feet in height, though the cañon itself is wide. In the deep cañon thus formed the great blocks of ice, loosed from the snow-fields, plunge often with such terrific force that it shakes the immediate region as in an earthquake, the deep detonations caused by the impact being heard a distance of ten and even twenty miles, the noise at a distance of ten miles sounding like distant thunder.[10] The river is capable of developing a great deal of water-power.

Raft, Queets, and Quinaielt rivers drain synclinal troughs, the trough of the latter still being laked in its lower middle course. These streams are all characteristic for having their channels incised in Pliocene rocks in their respective lower courses.

Remarks.—As a closing remark on the rivers of the region, it is found that the streams flowing into the Strait of Fuca usually follow faults and the streams on the Pacific front drain synclinal troughs, the lower courses of the latter streams being drowned in Pliocene and again in Pleistocene times.

Lakes.

There are many lakes in the region. Some are high up in the mountains and are known as the Happy lakes and the Frozen lakes, the latter being so named because they are frozen over most of the year. These are beautiful in summer, and in time will be of value as reservoirs for watering stock. To-day only elk and deer drink of their waters and wallow in their muddy beaches. The large lakes of the region are Lakes Pleasant, Beaver, Sutherland, Crescent, Ozette and Dickey.

Lake Beaver is a small body of water on the Clallam-La Push wagon-road some eighteen miles from East Clallam. It is a very beautiful lake, enclosed within high, rocky walls. Its depression

10. The Indians believe that in time of stormy weather a bird of monstrous size soars through the heavens and by the opening and shutting of his eyes it produces the lightning and by the flapping of its wings it produces the thunder and the mighty winds. This bird, they say, has its nest in a dark hole under the glacier at the foot of the Olympic glacial field and that its moving about in its home produces the "thunder-noise" there.

is caused by an upthrust of plutonic rock damming the channel of a little creek which now flows over falls and joins the Soleduck. If utilized these falls will furnish 1000 to 5000 horse-power for the running of mills, etc., depending upon the time of year. The position of the falls and the height of the lake (there are no signs of it ever having had a higher beach) seem to indicate that the plutonic dike which dams the stream is still being elevated. The lake is alive with trout of excellent flavor.

Pleasant lake is a little off of the road at the town of Tyee. It is a very small lake. It contains many trout and is a good "duck pond" in the fall of the year. It is due to the glacial damming of a small side stream of the Soleduck, the stream now flowing over the dam to the master stream. The lake once had an outlet farther to the northeast, but this has been silted up in recent times.

Lakes Sutherland and Crescent are in the east end of Clallam county. As we have seen, they are in a partially abandoned channel of a stream that once flowed from the south by the way of Wineton to join the Elwah. Indian creek is the remaining lower part of that stream. The laking is due to the differential uplifting of the bed of the stream in a former geological epoch accompanied by a sinking of the bed in the laked places The glacial drift also aided in this laking process. These lakes are seven and eighteen miles respectively from Port Angeles, and the latter is five miles from Port Crescent. Crescent lake is twenty square miles in area; Lake Sutherland twelve. They are both beautiful expanses of water surrounded by rocky walls, the walls surrounding Crescent lake being from 2000 to 3000 feet higher than the lake. This lake abounds in trout. It is now a summer resort, and cottages dot its shores wherever there is room for a cottage to be erected.[11] These lakes lie in the upper part of a synclinal trough, the northern end of which is truncated by the waters of the strait in the vicinity of Freshwater bay.

Lakes Dickey and Ozette lie in the western part of the Quillayute synclinal trough. They were protected from being filled by the northern glaciers that swept the region by Clallam Peak, which divided the glacier and caused it to pass around the present laked

11. The Quileute Indians have a myth about the origin of Crescent lake, as follows: "Once, in the valley which the lake now occupies, our people and the Clallams were having a big battle. For two days the people killed each other. Then Mount Stormking became enraged. You know the mountain that overlooks the north end of the lake from the east. Well, Mount Stormking got angry (all things on earth were living beings then) and he took a great piece of rock from his crest and hurled it down into the valley, killing all who were fighting and at the same time damming the stream with the great rock, so that it has been as it is now ever since, and no Indian has gone near the place since that day."

This myth causes the question to arise: Has there been volcanic activity in the region since the Indian occupation? Undoubtedly it was a volcanic region in Eocene times, but as yet evidence of later volcanic activity is wanting.

region with the greater bulk of its debris, filling the rest of the trough. Dickey lake is a very pretty expanse of water, covering several square miles in area. Ozette lake is one of the largest lakes in the state, being about thirty square miles in area. It lies near the Pacific coast, near the Indian village of the same name. It is very picturesque, and is dotted with several islands, one containing forty acres. This lake has an outlet now by way of the Ozette river to the Pacific; in former times its outlet seems to have been farther south down the coast in the vicinity of Yellow Banks, extending out from the south end of the lake. In the near future it will become a summer resort. Not only will it be valuable for that purpose, but various railroad companies are surveying it to the end of connecting it with the ocean by a locked canal, the latter being only a half a mile from the lake at its northern terminus. If this can be done, the lake will become an excellent harbor, and will add greatly to the commercial interests of the region.

Medicinal Springs.

So far as the writer can learn, but two sets of medicinal springs are found in the peninsula, and all are hot springs. One set, numbering some three or four springs, was found last year near the head waters of the Elwah river. Since then a health resort has been established on the site. The other springs are on the Soleduck river, ten miles down-stream from its source and about twenty-five miles from the south end of Crescent lake as the trail runs. The springs, many in number, gush forth from a fissure in the earth's crust, which here runs in an east and west line for miles. It crosses the channel of the river in the vicinity of the present bath-houses and the springs are found on both sides of the river, though only those on the south side are developed. The hot springs are strongly sulfur; but associated with them are cold magnesia springs, though issuing from the side-walls and not from the fissure. These springs possess medicinal properties. Though the accommodations have always been poor and the only road a trail, many people visit the resort every year. A corporation has now obtained possession of them, a road is being built from the lake to them, and an up-to-date bath-house and a sanitarium are to be built in the near future. For people having rheumatism and kindred diseases there is probably no better resort in the state of Washington. In addition, the picturesqueness of the site adds to its value. The valley here is enclosed between ridges and peaks 1000 or more feet in elevation above the level of the river. On these roam the deer and elk, while two miles to the southward are open

parks and beautiful lakelets, and a mile still further south is "Observation Point," from which those who desire to climb may see the surrounding country from the blue ice of the Olympic glaciers to the stormy capes at the entrance of the Strait of Fuca. But the question which particularly interests the geologist is why these springs are hot? It will be seen when the geological part of the article is discussed that in the Eocene epoch there was considerable volcanic activity in the region in the vicinity of Point Crescent and Freshwater bay and extending inland to the Crescent lake region. It therefore seems probable that, though primary volcanic activity has been non-active since that far-away time, secondary activity in the form of hot springs is still active, the earth's crust within still being hot near the surface here.

GLACIERS.

The glaciers of the region, except a few temporary ones of small area, lie in the depression on the northwest slope of the central mountain mass between Mounts Olympus and Constance, and cover some two townships in area when at their minimum size in August of each year. The ice mass seems to be several thousand feet in thickness, and in its downward movement is caused to project out far over the cañon walls of Glacier creek and Hoh river, leaving a dark hole-like space beneath it, the supposed home of the "Thunder bird," according to the Indian myths. A fissure loosens a great block of this snow-field now and then and it plunges to the bottom of the cañon, 2000 feet below, with a terrible crash. This glacier was very extensive in glacial times, reaching down the Hoh valley, even beyond the present shore-line, to Destruction island. Its retreat was slow, and a halt of long duration is now marked by a benched area in the middle section of that valley, the terminal moraine of the glacier at that time. There is also evidence that the glacier covered other faces of the mountain mass in the Glacial epoch. In recent times it has been reduced to a mere mountain cap. But few people have ever visited it, and of its surface appearance practically little is known.

THE PRAIRIES.

Large areas of open, untimbered, grass-covered lands are found in the mountainous portions, mostly upon the tops of the ridges, between elevations of 4000 and 6000 feet. They are scattered among the bunches of timber at timber-line. Their total area is about 250 square miles. In the near future grazing in these parts will no doubt become a profitable industry.

Besides the open grassy lands at timber-line, several prairies are

found in the lower country west of the mountains. They are named as follows: Quillayute, Forks, Shuwah, Tyee, Beaver, and Oberg. In area they aggregate about 4000 acres. They have a black loamy soil of vegetable mold, and are extremely fertile. They were the first parts of the interior country settled, and are still the centers of population in that section. The cause of these treeless areas surrounded by an ocean of giant timber is somewhat a puzzle. They have rich black soil, which the rest of the region does not have. At first sight it would seem that likely they had been marshes, and had only recently been drained—so recently that the forest had not yet claimed them. This seems to explain the origin of Forks Prairie, at least in part, as there is evidence that it is the abandoned channel of the Calawa river; but it does not seem to be an explanation of the origin of the other prairies, as they are all high land. Quillayute prairie is on a bench, and Beaver prairie is on a semi-hillside, and there is no evidence of their having been marsh or swamp, the loam being composed of decayed ferns and fern roots. Another explanation suggests itself—that they were ponded areas in glacial times or the out-wash areas at points where glacial streams escaped from the ice-sheet; but the clayey composition of the subsoils would seem to show that none of these causes could have been the origin. Still another theory is that the black soil of the prairies is the deposits of sediments in lakes or swamps superimposed on the ice-sheet, and that at the melting of the ice at the close of the Glacial epoch, the sediment was dropped *in situ;* and that, being such rich soil, the ferns took possession of such area and have always kept the timber out by their rank growth. This would easily explain why the prairies are on high ground for the most part; but that the rank growth of ferns kept the forest from taking possession of the areas does not hold good; for a piece of land of any of the prairies let grow up to ferns will soon be taken possession of by young trees—in a few years a young forest—as has been demonstrated time and again in recent years.

Another theory, and one which seems to be a satisfactory explanation, is the following: It is noticeable that the prairies follow the river and are about a day's journey from each other for a canoe man. Also, the Indians fished and hunted throughout all this region formerly and their only highway was the river. Is it not possible that these prairies were the camping places of the aborigines. And again, to strengthen this theory, the Indians dug fern roots from these prairie regions, dried them, and made them into a

kind of flour which they made into a paste-bread. These roots they gathered both in the fall and in the spring. And at each gathering in the fall they burned the prairie over so they could find the roots easier, and also so that they could see the elk that would attempt to cross the open area; for the ferns grew higher than a horse's back. Thus by this burning year by year, the prairies were extended. It would seem, therefore, that the treeless regions were first started as camping places, though originally some trees might have been blown down in each area by a storm; and that they were enlarged year by year by the annual burning of the ferns. But an objection might be raised to this theory, that no tree-roots have ever been found in the prairies proper. This objection may be answered that since the first Indian occupation there has likely been a lapse of time sufficient for all roots of the then existing trees to decay, exposed to the elements as they would be. The black loam is the decayed fern roots that have accumulated in the countless years since the first fires destroyed the timber.

Some of the other prairies are Long prairie (600 acres), Gibson prairie (300 acres), and Sequim prairie (4000 acres). The latter is irrigated land and produces large crops. It is on the Puget Sound side of the Olympics.[12]

TOWNS AND HARBORS.

Gray's Harbor is a large, elongated, triangular-shaped expanse of water extending inland from the Pacific ocean, about sixty miles north of the mouth of the Columbia river. Its base is toward the ocean, from which it is separated by sandy spits. Its outlet to the sea is partly closed with sand in shallow water. The government has spent a million dollars or more in dredging this outlet so that large ocean liners may enter safely; but only partial success has been accomplished so far. Around the harbor have grown up sev-

12. Below are some Indian myths about the origin of these prairies, which, though not very scientific, may interest the reader. Myths used by permission of the Bureau of American Ethnology.

The Thunder bird and the myth about the origin of Beaver prairie at Beaver, Clallam county, Wash. (Police Hobucket):

"The Thunder bird lives in the heavens. He produces the lightning by his rapid flight through the air, the 'big noise' by the flapping of his wings. He feeds on the whale. Once he got a big whale in his talons and carried him to Beaver prairie and ate him there. The whale fought terribly hard before he was killed. So terrible was the fight that in the struggle the combatants killed all the timber in the vicinity and pulled up the trees by the roots. And no trees have ever grown on the site to this day."

The Thunder bird, the unsuccessful battle with the *Mimlos*-whale, and the origin of the prairies of the Olympic peninsula (Police Hobucket):

"At the time of the great flood the Thunder bird, the representative of good, fought the *Mimlos*-whale, the representative of evil. The great battle lasted for a long time. For a long time the battle seemed undecided. The powerful bird could not whip the beast in the water. Time and again it seized it in its talons and tried to fly with it to its nest in the mountains; but the powerful ocean monster would get away from it. Each time that it seized it there was a terrible battle, and the 'big noise' caused by the bird's flapping its wings (the thunder) shook the very mountains. The places where these fights occurred were stripped of their timber, the trees being torn out by their roots. A curse was brought upon them, and to this day no trees grow

eral small towns and the cities of Aberdeen and Hoquium. And Mr. Hill has made it the terminus of one of his transcontinental railroads, and other roads are being headed towards it with a view of entering the Olympic country from that point. Lumbering is the principal industry of the region in the vicinity of the harbor, and here are located some of the largest lumber mills in the state of Washington.

Moclips is at the terminus of the northern extension of the railroads from Gray's Harbor. It has an excellent, open sandy beach. At the present time it is a summer resort.

La Push is the Indian village at the mouth of the Quillayute river. It is a picturesque place, and has a population of 231 Indians. From time immemorial it has been the home of the Quileute (or Quillayute)[14] Indians as it is to-day. At the present time it is governed by the teacher in charge of the United States Indian school located in the village. Were the Indian reservation thrown open, there is only one thing lacking to make this place a large town. That is a safe harbor. This it practically once had, at least for schooners, at the time the river entered Quillayute bay, but the change in the mouth of the river altered all this.

At the present time everything must be brought into the country over the road from East Clallam, on the Strait of Fuca, or on the sea by way of La Push. Most of the merchandise which is brought into the interior country comes by the way of Clallam bay. But little is brought by way of La Push, except such supplies as are brought for the K. O. Erickson-Taylor store at Mora, four miles from La Push—about three or four schooner loads a year; the schooner lies

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upon them. They are the prairies of the country. At last the whale escaped to the deep ocean, and the Thunder bird gave up the fight. That is why the *Mimlos*-whale or killer-whale still lives in the ocean to-day."

The Thunder bird and the origin of the Glacial Boulder-Train ridge across Beaver prairie (Police Hobucket):

"A man was living at Wo-lot (Beaver prairie). He was an elk hunter. He went off hunting very early one morning, but soon came back, saying that he had seen a very big bird sitting in a tree just a little way above the ground. This bird was the Thunder bird. That man took one feather from thunderer's wing. It was just as long as a canoe-paddle. He bent the feather and put it into his quiver and brought it home with him. After he had showed this feather to the people he said: 'I also saw a very, very large whale on the prairie. It had been carried there by the bird. The bird was resting, because he had such a big load.'

"The man sent word to all the Quileute people at the mouth of the river to come up and cut up the whale, because it was so large that the bird could not carry it further. All the beach and river Indians, three to six in each whaling canoe, came at once to the prairie to cut up the whale. On reaching there they found the huge whale lying dead at the lower end of the prairie, as had been reported. They immediately commenced measuring off the parts they wanted; one family took the head, another the saddle, and so on. By evening they had it all cut up. They piled up the block-like sections of the blubber all over the ground. Night came on; and the clouds overhead became black. The Thunder bird had been robbed of his prey and now he was returning with vengeance in his wings. It commenced to lightning and to shower a little, not so much at first. Then it hailed large hail, hail larger than your fist. The hail killed and mangled all the people on that prairie. The Indians had cooked and eaten whale meat that evening; and it was all right, it was good to eat. But after the storm both the meat and blubber were turned to stone; as were the people also. And to-day, in great blocks of rocks, they form a ridge from one end of the prairie to the other. One may even see the ribs of the whale's carcass and its massive head."

14. Geographers spell the word "Quillayute." The Indian office spells it "Quileute."

at anchor in the harbor while the goods are brought ashore by Indians in Indian canoes. The cost of bringing in goods by way of Clallam bay is about twenty dollars per ton for the inland freight charges and five dollars per ton from Seattle to East Clallam. These rates keep imports down to the lowest limit and practically prohibit exporting.

If there were any easy means of exporting, it is probable that sawmills would be established at the mouth of the Quillayute river. As has been shown, there is an abundance of good timber in the country, and good sites for mills are to be found near the mouth of the river. Also, supplies from the outside world could be obtained more cheaply than at present.

A map of the Quillayute harbor and river, shown elsewhere, shows that the harbor is well sheltered on the northwest but open to the southwest storms, the prevailing storms in winter. Although the harbor is hemmed in by precipitous cliffs and high, rocky islands, it is itself entirely free from rocks. Its prevailing depth is twelve feet at low tide, 800 feet from the low-water line of the beach, and the bottom slopes regularly toward the ocean. At the entrance of the bay there is a general depth of six to seven fathoms. The mean range of the tide is about eight feet. The mouth of the river, as we have seen, was formerly at the north end of this bay; but about thirty years ago this mouth was silted up and the river formed a new mouth through a sand-spit three-fourths of a mile up the river from the old mouth. The width of this mouth varies according to the seasons. At the present time it is a little over fifty feet wide at low tide.

The bay into which the river now flows is rocky, exposed and dangerous, and there is a rapids in the river and a bar just off its mouth. No improvement of the present mouth is feasible. The improvement needed is the reopening of the old mouth of the river. The lagoon which formerly formed part of the river is separated from the ocean by a narrow sand-spit about 300 feet wide at high tide, and, having a maximum elevation of about twelve feet at low tide, the tide backs the river-water into the lagoon at high tide. This lagoon at the south end has a depth of four feet at mean low water, as referred to that datum in the ocean, but the actual depth is about eight feet, as the surface of the water in the lagoon is about four feet higher than the ocean when the tide is out, on account of the north end, the outlet of the lagoon, having been choked up with sand to a height of four feet above mean low water. To reopen the old mouth of the river it would be necessary to close

the present mouth with a dike, to protect the sand-spit between the existing lagoon and the ocean, and to make a cut across the sand-spit to the south of the lagoon into the Quillayute harbor.

The estimated cost of this improvement is as follows:

Dike of piles, brush and stone, 1000 feet, at $5 per foot....	$5,000
Protection sill of brush and stone, 4400 feet, at $2 per foot..	8,800
Excavating cut across sand-spit...	3,200
R moving snags and other obstructions by blasting	1,200
Engineering, superintendence, and contingencies, 10 per cent.,	1,820
Total.....	$20,020

Or, in round numbers, $20,000.

In summer the river is low and does not carry much water. In the spring and fall, however, the water is high and the current rapid. The fall freshets are due to the heavy rains and the spring freshets to the melting of snow on the mountains. The river reaches its greatest height of about ten feet above low-water stage during the fall freshets, usually in November. It is probable that if the improvements as outlined above were made during the summer the fall freshets would scour out the channel through the lagoon and across the sand-spit into the Quillayute harbor, as the material at the north end of the lagoon would be readily moved by the current, and the sand-spit between the lagoon and the harbor would be easily scoured away.

The reopening of the old mouth of the river is the most practicable and feasible scheme of improving this river and harbor. An objection to this improvement is that the bay, though protected from the northwest storms, is exposed to the prevailing southwest winds of winter, and that heavy seas would break directly into the mouth of the river; but at such times the tides run high and the schooners could anchor in the river up from its mouth and be safe from the sweeping storms. Moreover, it would afford a safe outlet to any logs which might be cut and put in the river. Also, it would afford an opportunity to float sawed timber out on lighters to vessels which might be at anchor in the bay. [15]

Neah Bay was a possession of the Spaniards, as we have seen. For many centuries it has been the home of the Makah Indians, though they succeeded another race, likely the Quileutes. Near this village lives the Indian agent of the Neah Bay agency; and on an island opposite the Indian village there is being built the Pacific life-saving and wireless telegraph station. It has a good harbor but is exposed to the northwest storms. The building of a breakwater from the mainland northwest of the bay to the island

15. Partly after Capt. Harry Taylor, report on "Quillayute Harbor and River, Washington," August, 1897, under river and harbor act of June 3, 1896.

on which the wireless telegraph station is being installed would make it safe. This likely will be done in the near future, as the channel is narrow and not very deep. A protected harbor should be located at this place, as it is the last harbor towards the ocean in the Strait of Fuca. This town in time will become the northwestern terminus of the Olympic peninsula railroads.

Both East Clallam and (West) Clallam are located on Clallam bay. They have tolerably good harbors and each of the two has quite a lumber trade. At the present time East Clallam has the interior trade of the Olympic region. West Clallam will be a terminus of a branch of the Olympic railroads.

Port Townsend is located at the northeastern corner of the peninsula. It has a protected deep-water harbor. It is a medium-sized city, though not so flourishing as before the rise of Seattle and Tacoma. It is a United States revenue station and near it is located one of the forts that guard the strait. It is also the county-seat of Jefferson county. It occupies a beautifully terraced position overlooking both the sound and the strait.

Dungeness was visited by Captain Gray in his famous trip nearly 130 years ago, and the old hull of one of his boats may be seen out on the Williams' ranch, three miles from town, where he had anchored in what was for many years afterward called Gray's marsh, a safe harbor for the anchorage of all boats at the time Gray visited the region, but now a fine farm. The first settlement at the place was made in 1852 by one John W. Dornell, who had come around the Horn from Maine in that year. He was a file-maker by trade. He built the first grist-mill in Clallam county, a mill run by wind power. For many years he was justice of the peace of the place, and had the honor of marrying the first couple ever legally married in the county, finishing the ceremony with the words: "What God and I have put together let no man tear asunder."

For many years Dungeness was the county-seat of the county, but in 1890 the county books and records were taken by force, it is alleged, and transferred to Port Angeles, which has been the official town of the county ever since.

This town is in the midst of a fine farming section and dairy country. It is situated on a beautiful bay and harbor that is well protected from the storms that sweep the straits. A narrow arm-like spit extends out from the mainland west of the city and curves up the strait, completely enclosing Dungeness bay except on the east side. The spit is remarkable for its having a secondary spit developed

on its inner side. The spits are due to the strong tidal currents which flow through the adjoining straits at the rate of about five or six miles per hour, as is also the spit at Port Angeles, which will be mentioned later. The city they protect will grow as the country develops.

Port Angeles was discovered by the Spanish Captain Don Francisco Elisa. He had been tossed about for many weary days by storms and furious waves when suddenly he came upon a long, snake-like spit extending far out into the strait, curving so as to protect a large bay on its eastern side. In this bay Elisa took refuge; and in consequence of the safe and perfect harbor thus formed, he named it Port Angeles—"The Port of the Angels."

The narrow spit of land which encloses the bay-like harbor extends from the mainland shore north into the strait a distance of two miles. Then it gently curves to the east for nearly four miles, enclosing the large bay and leaving a broad, deep, wide, open roadway for the entering and going out of ships. And to make the harbor more perfect, it has a tenacious clay bottom, with no treacherous rocks to threaten the mariner seeking shelter within it.

In 1862 President Abraham Lincoln reserved a strip of land one mile deep and five miles long fronting this bay for a town site, amounting to 3520 acres. And the next year a small part of this reserve was sold in lots by the government at public auction. Then a short time afterward it became the seat of the United States customs office of the Puget Sound and straits country, but held it only a few years, when it was removed to Port Townsend. Then until 1890 the town was in a dormant state. But that year a boom came and the people made squatter town-site settlements all over the entire tract reserved by President Lincoln. Then they petitioned the government to throw the entire reserved town site open for settlement, which was done in 1894, Congress having appropriated $5000 to survey and appraise the land.

Now around the shores of this harbor is to be found the thriving city of Port Angeles. The site is unexcelled. Beginning with the bluffs overlooking the bay there is a gentle and continuous rise to the foot-hills, twelve miles away to the southward, above which tower the white-robed Olympics. Almost without exception every lot within the city limits commands a view of both the water and the mountains. Since 1890 it has been the county-seat of Clallam county.

GEOLOGY.

Introductory Remarks.

The high mountains form a circular area forty miles in diameter and 6000 to 8000 feet in height in the east central part of the peninsula. They are alpine in their central area, and are characterized by glacial sculpture, precipitous slopes, and high, barren ridges, with intervening prairie lands. From this central area, as has been stated, the streams radiate out toward the coast-line in all directions, the radial pattern being very perfect toward the coast region but less perfect in the mountain district. Along with the radial drainage-courses there also radiates outward from the central mass a system of ridges, the divides between the streams. Some of these ridges are due to erosive agencies. Many of them, however, are the result of uplift. Those along the Strait of Fuca are the upturned edges of fault blocks, the streams following the fault lines. Those radiating out toward the Pacific are anticlinal folds, the streams here occupying the synclines. These anticlinal folds jut out to sea as bold headlands, and still farther out as islands and reefs, and shallow-water areas known as "the banks." But to consider the region as a whole, the surface slopes gently seaward from an elevation of 5000 feet. The streams, therefore, seem to be consequent to some imaginary surface of double curvature. As will be noted later, neither volcanic debris nor Tertiary rocks have been found in the central mountain mass; nothing but upturned slates and sandstone and other rocks of pre-Tertiary age are found, and these pitched to a vertical position and the Tertiary of the lower country deposited upon their upturned, eroded edges. It would seem, therefore, that the radial drainage was initiated on the domed surface of a pene-plain.

Concerning the drainage of this region and its origin, Doctor Arnold says:[16]

"The drainage of the region is radial, the radial pattern being very perfect about the borders of the high mountains, while within the mountains it is less perfect. The streams of the peninsula are arranged much like the spokes of a wheel, of which the region of the high mountains is the hub. This pattern could have one of three possible origins: First, the drainage was initiated on a volcanic accumulation about a center; second, the drainage was initiated on the domed surface of Tertiary strata, which has since been removed by erosion; third, the drainage was initiated on the domed surface of a pene-plain. By all of these hypotheses the streams are consequent to some imaginary surface of double curvature. The first is disproved by the absence of extensive volcanic material.

16. Bull. Geol. Soc. Am., vol. 17, pp. 454-455.

Choice between the second and third hypotheses is not wise at this time, but there are fewest difficulties in the acceptance of the third hypothesis, that the drainage results from the doming of a peneplain."

To turn to the coastal region, it is found to consist of an elevated terrace resting upon a wave-cut platform, which extends along practically the entire coast from Freshwater bay on the strait to Grandville on the Pacific. The terrace ranges from 50 to 300 feet in elevation, the average being about 150 feet. It is composed of more or less resistant rocks, except from Port Townsend to Freshwater bay; it is there composed of steep bluffs or more or less incoherent Pleistocene deposits and the two sand spits previously mentioned. There are occasional stretches of the coast, however where the land slopes gradually down to the water-line, as, for in-instance, at the mouth of the Queets river and from Grandville to Gray's Harbor. Here the timber comes down to high-tide level, and the beaches are strewn with huge logs which have been undermined by the pounding tides and swept into the tumbling waters. Two ridges also face the water-front; the one between Crescent bay and Freshwater bay, the other between Pysht and Clallam rivers.

The terrace platform reaches its maximum width on the Pacific front where the gentle folds of the anticlines jut out to sea, the wave action being more intense on this side. The greatest width of this platform is about two miles, in the vicinity of the Flattery and Bodelteh islets at the mouth of the Ozette river, though a secondary platform extends out many miles further. The ridge here from which it is developed seems to be a monocline. On the primary platform are to be found islands in all stages of development, from partially isolated promontories to spike rocks and reefs. Destruction island, near the mouth of the Hoh river, and James island, at La Push, are the largest islands along the coast of Washington.[17]

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17. An Indian myth of how the headlands and promontories of the Washington coast were formed (Elon Mason):

"It was long ago, when people were animals and animals were people Kwatte was then still living on earth. He had his house on the beach near here; but he did not get hardly anything to eat, for the wolves of the region prowled the coast, caught all the salmon, ate all the berries, and devoured all of the animals of the woods, and gulped down all the fish eggs, that floated ashore. What was Kwatte to do? One day the chief of the wolves came along up the coast. He came to Kwatte's house. Kwatte pretended to be sick. The wolf came in. He made himself at home. Kwatte let him stay. That night he made his bed at Kwatte's house beside Kwatte's fire. Soon he was sound asleep. When he had been asleep for a considerable time he began to snore. He snored loud This was Kwatte's opportunity. He would now get even with the wolves; and he would also have some meat to eat. He got his knife; looked at it to see if it was good and sharp, then, finding it in good shape, he went to the mat on which the wolf was sleeping and severed his head with one blow. He then skinned the carcass and hung the skin up above the fireplace in his house to dry. Then he stored the meat safely under his bed. Then he went to sleep.

"The next morning, bright and early, a wolf came tracking his chief up the beach. He tracked him to Kwatte's house. He entered the house. Said he to Kwatte, 'Did you see Chief Wolf?' Kwatte answered, 'No, I am sick. I have not been out of my house. I have not seen him.' 'But, he came into your house. We tracked him here,' exclaimed the wolf. While wolf

The platform has an approximately horizontal surface, most of which is exposed at low tide. This is usually comparatively smooth, though occasionally large areas are covered with shingle rock, due to the platform truncating soft shale interbedded by occasional hard, thin layers of sandstone.

GEOLOGIC STRUCTURE.

"As indicated by the exposures along the coast, the structural lines in the region from Port Angeles to Gettysburg average approximately parallel to the trend of the Olympics, N. 70° W., S 70° E.; those in the Gettysburg-Clallam Bay territory almost perpendicular to this, or a little east of north, and those in the Clallam Bay-Cape Flattery stretch N. 30° W., S. 30° E., or again parallel with the ridges which extend along the coast in this region. A syncline, with its southern limb resting against the sandstones south of Lake Crescent and its northern one truncated by the waters of the Strait of Juan de Fuca, is the major structural feature of the Port Crescent-Gettysburg region. The Freshwater Bay coal-field is located in the northern portion of the trough of this syncline. A rather broad syncline, with its axis extending in a northeasterly-southwesterly direction, occupies most of the territory between Pysht river and Clallam Bay. The Clallam Bay coal-field occupies this synclinal trough. The region between Clallam Bay and Cape Flattery is formed by a great northeast-dipping monocline, the beds of which appear to have a total thickness of 15,000 feet."[19]

From the main ridge thus formed minor fault blocks extend out to the shore-line, on each of which the dip of the strata swings around from a northeast direction to a northerly, and in one case to even a northwesterly dip. The Bahada fault block is pitched northeast; the remaining fault blocks between Bahada Point and

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and Kwatte were talking, the wolf's slave, the blue jay, had gone over to Kwatte's fire to warm himself. As he was spreading his hands out before the fire, a drop of something fell on the upper surface of one of his hands. At once he perceived that it was a kind of oil. He smelled it. At once he recognized it to have the same smell as the smell of his master. He said nothing, but went out of the room. The oil had dropped from the skin that was drying. As soon as he was out in the yard the blue jay told all the wolves what he had discovered; many wolves had now followed the track to Kwatte's house. The blue jay was crying, mourning the death of his master. The wolves all rushed into the house. Kwatte had anticipated trouble, and had hung a basket of combs near the door. As the wolves entered he made a quick move, seized the basket of combs, and before the wolves could lay hands on him he sallied forth out the door past them and into the woods near by and then down the beach. The whole pack of wolves now followed him in hot pursuit. Time and time again they nearly overtook him. But as they were just in the act of seizing him he would take a comb out of the basket and drop it down on the beach in front of them, thus forming a point of land projecting from the mainland across the beach into the surging waves. The wolves, of course, were compelled to climb over the promontories thus formed Many of them they climbed over; but finally they gave up the chase. But Kwatte kept on running till he had stood up all his combs on the beach.

"A long time afterward he came back, dressed himself in the dry wolf hide, and went to the house of the wolves and danced and sang before them, thus clad. And they dared not touch him, because of the wolf-skin dress that he wore."[18]

18. Used by permission of the Harrison Publishing Company.

19. (Arnold.) Bull. 260, U. S. Geol. Surv., p. 416.

the mouth of the Hoko river are pitched toward the northwest. Along each fault a small stream finds its way to the Strait of Fuca.

In the Cape Flattery promontory, which is separated from the rest of the highland area by a fault and by the Waatch river, the strata are much broken in the sandstone districts and contorted in the shaly sections, the shale looking much like it had been run through a giant crimping machine; but in a general way all the strata of this area from the strait to the Pacific dip north, varying from northeast to northwest. The higher angle of dip is on the Pacific side. It here reaches even sixty degrees. The promontory, therefore, forms one great monocline.

East of Waatch strait and south of the Clallam Bay-Cape Flattery monocline is the western extension of the axis of the Olympic mountains. This has been a line of disturbance, and consequently the structure is quite complex. South of this axis and extending eastward sixty miles is the wide synclinal Quillayute-Ozette trough. Then along the coast to the mouth of the Hoh river and extending from there to the Happy lake country, as we have seen, is a ridge which, from the mouth of the Hoh river westward, is narrow and roughly parallel with the main axis of the western extension of the Olympics, mentioned above. The dip of the strata is also north, varying from northeast to northwest. As a result of this change of dip, several determinable folds with northwest-southeast axis are formed, which now extend out as the headlands and rows of islands off the coast. Folds and intervening synclines are also noticeable south of the Hoh river, all with axis parallel to the ones previously mentioned. In the vicinity of the mouth of the Quinaielt there is a prominent syncline developed in the Pliocene (Arnold).

FORMATIONS IN DETAIL.

Geologic Formations.—The formations of this region, so far as known, are as follows: Supposed pre-Cretaceous, supposed Cretaceous (tree stages), Eocene, Oligocene-Miocene, Pliocene (two stages), Pleistocene, and recent.

Supposed pre-Cretaceous.—Rocks supposed to be pre-Cretaceous in age are found in the central Olympic region(?) (not mapped); in the central ridge which extends westward from the Olympics to Cape Flattery(?) (mapped where known to occur as surface rock); and on the Pacific front at Portage Head, eight miles south of Cape Flattery, and at the Point of the Arches, four miles further south, and in the region from Point Granville south to within a few miles of Gray's Harbor, and a few other smaller exposures along the

Pacific shore-line. So far no rocks of this age have been found on the north slope of the peninsula.

In speaking of the rock structure Professor Gilman says:[20]

"The country rocks of the mountains are syenite, gneiss, quartzite, protogene, crystalline and chlorite schists, slate (hard, black, flinty, to soft, green, talc), shale, sandstone, trap and basalt."

The series containing the syenite, gneiss, quartzite, protogene, crystalline and chlorite-schists is here placed by the writer in the supposed Cretaceous. Its approximate area is not known, neither is its thickness where the central core of the western extension of the Olympics is exposed. Along the east and west axis of the western part of the peninsula at Beaver Falls, on the East Clallam-La Push wagon-road, which is composed of a very hard, dark-gray plutonic rock of more than 10.000 feet in thickness. This core, however, is exposed only in patches. Its greatest thickness is in the vicinity of Clallam Peak. Towards Cape Flattery it is capped with sedimentary deposits. Here it is composed of metamorphosed sandstone and quartzite. It may prove to be of Eocene age.

At Portage Head, Point of the Arches, and at Point Granville the type rock of this old series is conglomerate, quartzite, old diabase or greenstone, serpentine, etc.

This old series, wherever found, is much fractured and faulted and cut by quartz veins, which occasionally carry gold and silver in small quantities. The principal veins carrying precious metals are found in the Point of the Arches group and in the vicinity of Clallam Peak and Beaver Falls. An odor of benzine is also given off from the serpentine and conglomerate rocks of this group in the Point of the Arches, derived likely from the shales that are found a mile further south. There are no other shales or oil-producing rocks in the vicinity; the age of these shales is in doubt, but they are Cretaceous or still younger.

As a closing remark on this formation, the observations seem to show that the oldest rocks of the peninsula are those on the Pacific coast mentioned above, together with those in the Clallam Peak group (?). The Pacific coast groups were islands in a Cretaceous sea, and around them were deposited the next formation described. The western extension of the Olympic axis, including the Clallam Peak group, was caused by an upthrust movement along this line at or near the close of Miocene times. Where the mainland mass was in pre-Cretaceous times cannot be even suggested at this time.

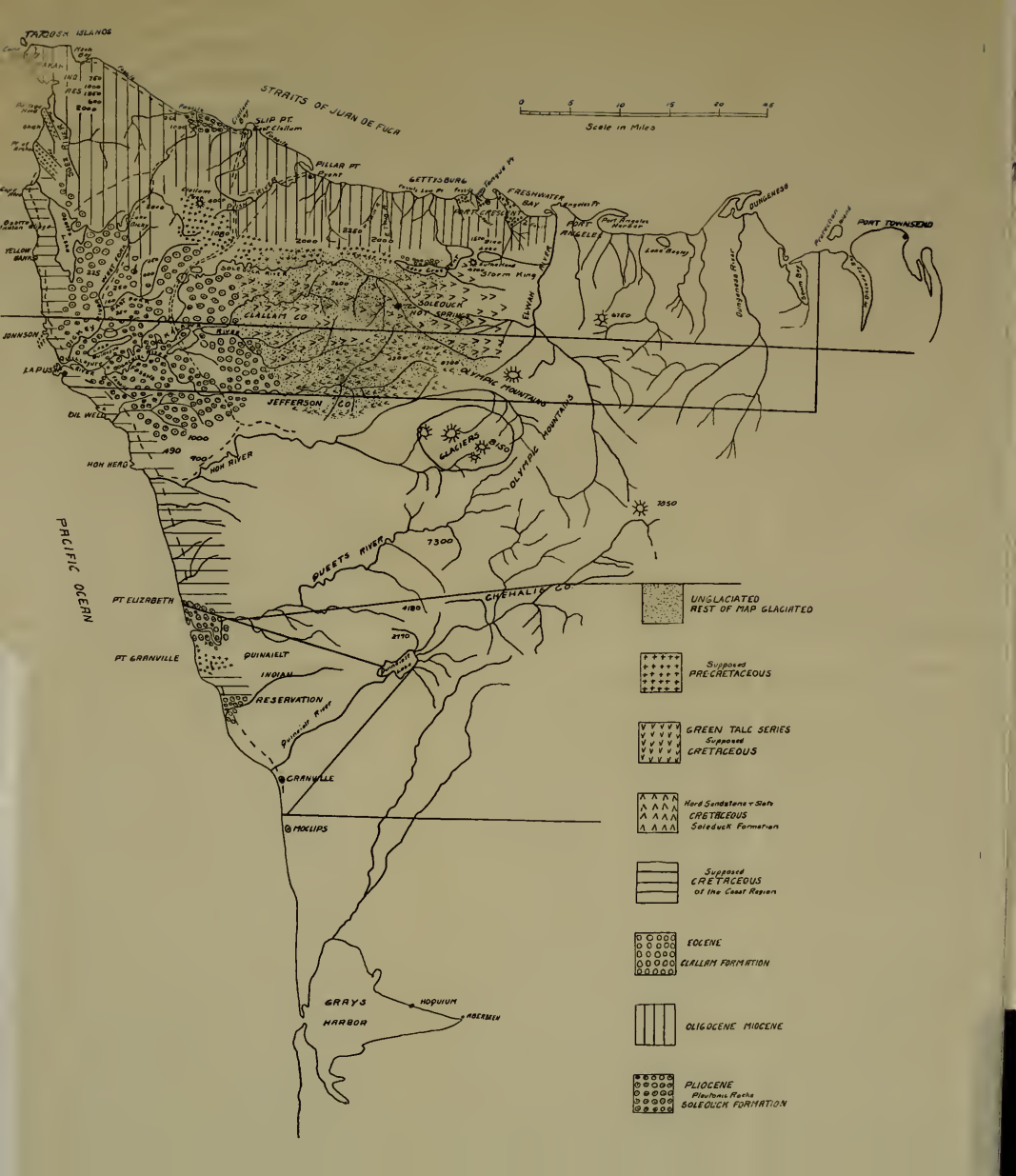
Supposed Cretaceous.—There are three groups of rocks which

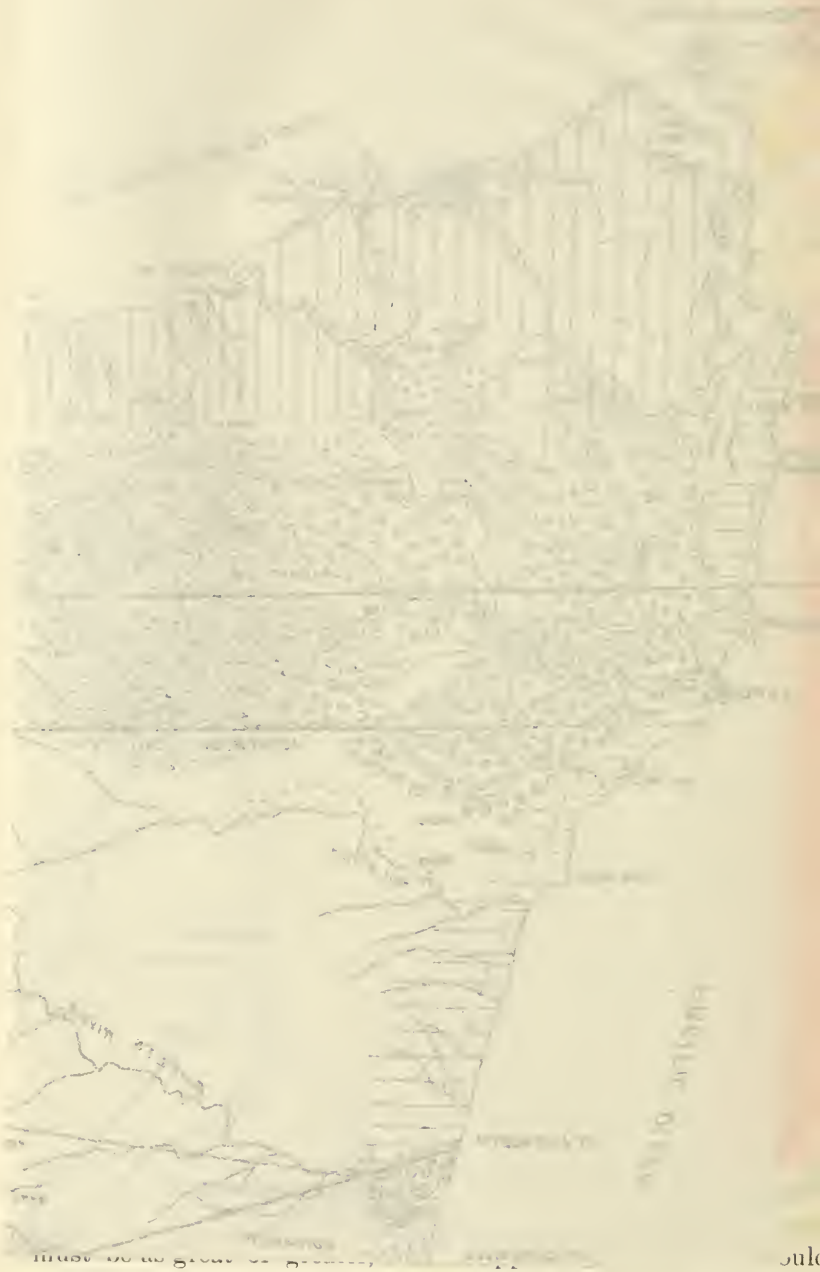
20. National Geographic Magazine, vol. 7, 1896, p. 138.

are here placed in the supposed Cretaceous list: The soft to hard green slate (talc) of the upper Bogachiel country; the hard gray sandstone and flinty slates of the north slopes of the Olympics; and the pre-Oligocene rocks on the Pacific coast not given in the previous supposed pre-Cretaceous list. The correlation is based on the stratigraphic position and the lithologic character of the rocks.

The green talc series is found in the Bogachiel valley near the head waters of that stream. It is several thousand feet in thickness. For the most part it is a soft slate interbedded with gray sandstone and some shale. It is pitched nearly to a vertical position, with a trend of dip between a southeast and a northwest and an east and west direction in the region visited. The next formation described above is superimposed upon it. It extends to the Hoh valley and likely to the region of the glaciers, judging from the milky-colored sediment in the glacial waters of the Hoh river. It is also found unconformably beneath the supposed Cretaceous sandstone series of Johnson Point on the coast north of the mouth of the Quillayute river. It is in this formation that the Bogachiel and Hoh rivers have cut their respective cañon-like channels. No fossils were found in this formation. On account of its reaching its greatest development in the Bogachiel valley, it is here termed the Bogachiel formation.

The second group of supposed Cretaceous rocks extends from the Eocene exposures near Port Crescent south to about four miles south of the Soleduck Hot Springs. At the north it is mostly hard gray sandstone; but nearing the Soleduck, and between the tributaries of that stream, it is for the most part a flinty, dark-colored slate, though soft carbonaceous shales are found exposed on the south slope of the ridge which separates the main channel of the Soleduck from its northern fork. On weathering the flinty slate takes on an iron-rust color In this region it was found that the nucleus of all the ridges was this flinty slate; the streams have cut their channels in the softer sandstones and shales. From the Soleduck Springs south to the top of the Soleduck-Bogachiel divide the formation is alternating—very hard to soft shale and sandstone. The rocks are raised nearly to vertical position, the trend being nearly east and west. South of the river about 20,000 feet of continuous rock are exposed on the surface; and, the rock standing practically on end, its thickness would be about the same number of feet. North of the Soleduck the thickness of the rock must be as great or greater, but its approximate thickness could not be determined, as the country is much broken by faults. And


TARTOOSH ISLANDS
STRAITS OF JUAN DE FUCA
Scale in Miles
0 5 10 15 20 25
SLIP PT.
Fort Chilliam
PILLAR PT.
GETTISBURG
FRESHWATER BAY
PORT ANGELES
DUNGENESS
PORT TOWNSEND
Storm King
SOLEDUCK HOT SPRINGS
CLALLAM CO.
ELWHA RIVER
OLYMPIC MOUNTAINS
JOHNSON
LA PUSH
JEFFERSON CO.
OIL WELL
HOH HEAD
HOH RIVER
GLACIERS
PACIFIC OCEAN
QUEETS RIVER
PT. ELIZABETH
GRAYS HARBOR
PT. GRANVILLE
QUINAILT INDIAN RESERVATION
QUINAILT RIVER
GRANVILLE
MOCLIPS
HOQUIUM
ABERDEEN
UNGLACIATED REST OF MAP GLACIATED
Supposed PRECRETACEOUS
GREEN TALC SERIES Supposed CRETACEOUS
Hard Sandstone & Slate CRETACEOUS Soleduck Formation
Supposed CRETACEOUS of the Coast Region
EOCENE CLALLAM FORMATION
OLIGOCENE MIOCENE
PLIOCENE Pleistocene Rocks SOLEDUCK FORMATION



must be as great or greater, [illegible] could
not be determined, as the country is much broken by faults. And

the faulting still continues; the present ridges contain great cracks and fissures, often miles in length, and show every sign of even recent earthquake disturbances.

Below is a partial section of the rock of the ridge which separates the Soleduck from its north branch (the North Fork) 600 yards above the bridge on the government trail, beginning on its down-stream side:

Gray sandstone	100	feet.
Very flinty, dark slate, weathering to an iron-rust brown,	120	"
Gray sandstone	40	"
Dark slate, often having the luster of hard coal	300	"
Gray sandstone	20	"

This formation is seen to dip under the Eocene of the Port Crescent region(?). In two summers the writer was unable to find a fossil in it. For convenience this formation will hereafter be called the Soleduck formation.

The third group of supposed Cretaceous rocks is exposed on the Pacific coast and extends as a narrow strip from about two miles south of the Point of the Arches to near Cape Elizabeth on its northern side. It consists of coarse gray, often very massive sandstone, with occasional zones of dark shale, which is coal-bearing in a few places, though the veins are always thin. A conglomerate rock is also found interbedded in the formation now and then. This formation also extends to the islands off the coast. The axis of the uplift has a general southeast-northwest trend, corresponding roughly to the coast-line and the trend of the dip of the strata, which dip in a general way to the northeast, varying locally to a northwest dip in many places. The angle of the dip varies from thirty degrees to sixty degrees, averaging about forty-five degrees in the vicinity of La Push. The formation extends inland, from a mile in the vicinity of Ozette lake to about two miles at Johnson Point, while south of the Quillayute river it widens eastward.

From the farthest island off the coast to the most northerly limit inland of this formation, on a line at right angles to the trend of the dip of the strata, the distance is about six miles. The average dip being forty-five degrees, this would give more than 15,000 feet as the thickness of the rock thus exposed, 10,000 feet of which is in the submerged platform. [21]

The series is characterized by its having calcite veins running through it in all directions. These are abundant in nearly all ex-

21. One of the islands off the coast is characteristic for having its strata dip southwest, directly opposite to the dip of the strata of its sister islands; this seems to be due to some local faulting.

posures, but are most pronounced in the rocks of the islands off the coast, especially in those exposed in the Jagged island group.

Indications of oil are very noticeable in the soft gray sandstone of this series about a mile south of the Point of the Arches, and also at several locations on the coast south of the Quillayute river. Oil-springs also occur on Hoh head a mile north of the mouth of the Hoh river. Oil is also said to have been found at several places down the coast south of the Hoh.

This formation may be a continuation of the sandstone series of the Olympic region; but lack of time has prevented the writer from making a detailed examination of the middle Soleduck-Bogachiel country. The formation seems, however, to continue as a ridge to the mountains, as the divide between the Hoh and the eastern tributaries of the Quillayute.

This formation is not a continuous wall along the coast farther west than the mouth of the Quillayute river. From that point northwestward it has been broken through by streams and the sea at different times till now it represents "island" patches surrounded on three sides by unlithified material and on the front by the sea. They were islands in the Pliocene and Pleistocene times, as will be stated later; now they are often mere headlands, peninsulas or semi-islands, where the later deposits have not been entirely removed from them so that they again stand out from the coast as islands. They are the last remnants of this supposed Cretaceous ridge. To consider them as a whole, they may be termed "monadnocks."

Eocene: Crescent Formation.—This formation has a very limited exposed area. It comprises only the region in the vicinity of Crescent Bay and the prominent ridge which extends along the coast from this bay east to Freshwater Bay and some of the ridges that lie west of the south half of Lake Crescent (?). It is composed of volcanic material throughout. Its lowest exposure is on Tongue Point, on the west side of Crescent Bay, though the base of the formation is not there exposed. There it is black massive basalt some 200 feet in thickness. Superimposed upon the basalt are about 200 feet of greenish basalt tuffs and tufaceous sands. And superimposed upon this series are again 200 feet of black vesicular basalt; the whole likely representing several surface flows. A Freshwater Bay section also gives 600 feet of basalt and massive basalt tuff at base of exposure. On this are exposed 400 feet of thin-bedded green tuff, over which are superimposed 200 feet of

black vesicular basalt. Another small exposure is also found on the coast about a mile west of Tongue Point.

The age of this series of rocks is easily determinable. The roughly bedded tuffs in their upper portion are fossiliferous. In them Doctor Arnold found *Venericardia planicosta* Lamark, *Turritella uvasana* Conrad, and other characteristic fossils which indicate the Eocene age of the series and its general contemporaneity with the Tejon of California.[22]

This volcanic formation is very extensive, but is mostly covered up with later deposits; the conglomerate series of the next formation above it, even to Cape Flattery, is made up in part of fragments of basalt and basalt tuff, and is the only volcanic rock exposed *in situ* in the region. The portion exposed is separated from the later rocks by an erosive period and by faults.

Oligocene-Miocene: Clallam[23] *Formation.*—This formation is extensive and is found superimposed upon the Eocene and older rocks from Freshwater Bay to Cape Flattery along the Strait of Fuca, extending to the Pacific in the Cape Flattery promontory.[24] It is composed of conglomerates, sandstones, and shales, the latter two being rich in fossils. The conglomerates are found mostly at the base and near the top of the series along the strait and in the middle of the Cape Flattery series. A generalized section of this formation, from Freshwater Bay to Waatch Strait, by Doctor Arnold, gives the following:[25]

Coal-bearing coarse sandstones and conglomerates..	500 feet.
Massive gray shales and fine gray sandstones.....	1,300 "
Fine gray shale, massive at top, thin-bedded below,	975 "
Coarse conglomerates, with occasional sandstone layers and lenses.....	875 "
Total.....	3,650 feet+.

And the Waatch-Neah Bay section gives 15,000 feet of conformable strata, all of which seem to belong to this age of rocks.

Along the coast the shales occur principally in the middle of the series. In the vincinity of Crescent lake they seem to be wanting altogether; the walls of the lake where examined at the eastern terminus of the lake were composed of a dark-colored coarse to

22. Bull. Geol. Soc. Am., vol. 17, p. 460.

23. Following Doctor Arnold, it is deemed best to use the above term, as the separation of the two members of the group will necessarily have to be made on paleontological grounds, and the writer does not feel that material enough has been collected to make that possible at the present time.

24. Since this paper was written a fossil, *Thyasira bisecta* Con., has been found in the shale on the Pacific front three miles south of La Push and one and a half miles south of the old oil-well prospect. This would seem to place even the coast series (supposed Cretaceous) in the Miocene, at least all the rocks above the conglomerate series exposed on the coast.

25. Coal in Clallam county, Wash., U. S. Geol. Surv., Bull. No. 260, p. 415.

gravelly] sandstone, approaching the conglomerate stage. From Gettysburg] westward in from the coast a few miles to the top of the divide the country rock is generally shale; along the East of Clallam-La Push wagon-road it is the country rock from a mile south of East Clallam the whole distance to the summit of the divide. This shale at its base is thinly bedded and plainly laminated, but higher up in the series becomes almost massive clay, while in the disturbed central region it becomes a hard slate or "slag-like" rock.

The whole region from near Port Crescent to Gettysburg exposes shale. This contains nodules, boulders and concretions of flint; sometimes the flint forms a partial stratum. The shale is dark brown on exposed surfaces; otherwise irony gray. An overthrust is shown in these beds about a mile west of Gettysburg; and near that place hydrogen sulfid gas was noticed to be escaping from cracks in the shale. Sandstone dikes also cut the shale now and then in the region between Twins and Pysht; these are likely derived from the interbedded sandstone.

Where the Hoko river cuts its cañon through the Olympic axis, it exposes hard slate, shale and sandstone. The block of slate east of the river here dips generally to the northeast. On the ridge the dip is only about ten degrees; but as the straits are neared it becomes steeper and steeper, reaching even seventy degrees in some places. From the main ridge here several cross-ridges extend southward, apparently of the same formation.

From the Sekiu river a mile and a half in from the straits there runs a ridge northward to Neah Bay, with northeasterly dipping strata. The rock in the center of this ridge is a dark, very hard, "slag-like rock," between a flint and a slate.

The basal conglomerate is usually very hard and is composed of pebbles and cobbles of granite, gneiss, quartzite, jasper, agate, black to green slate, and volcanic rock, mostly basalt and basalt tuffs. In the upper conglomerate series the volcanics are mostly wanting.

The sandstones, for the most part, are thin-bedded, hard, and resistant to erosion. At East Clallam they are immediately below the upper conglomerates, and in the Cape Flattery promontory they are found at the base and near the top of the formation. They are quite fossiliferous, especially at Gettysburg and East Clallam. In them, especially at Slip Point, fragments of coal are found and thin, taperingout layers of impure coal of the lignitic type are occasionally met with; while towards Pillar Point from East Clallam are the Clallam coal-beds of this formation, a mention of which

will be made later. The scattered fragments of coal in the sandstone seem to have been formed from driftwood; each fragment of coal so formed seems to have been a fragment of a log or stump isolated from all other coal-producing material.

About a half-mile up the Sekiu river, and at several places along the coast from the mouth of that river to Neah Bay, a massive sandstone was observed which contains concretions of fine, very hard, bluish-gray sandstone containing fossils; some of the concretions also contain pyrites of iron. The concretions resemble Doctor Newcomb's "boulders" of the Carmanah Point formation on Vancouver Island adjacent;[26] and as the fossils are similar it is likely that the formations are the same. In the sandstone series here, especially in that exposed along the Sekiu, there are occasionally small veins of coal, a sort of "decayed vegetation." The veins exposed are too small and the coal is too poor in quality to ever pay to handle.

The cap-rock from the Sekiu to Neah Bay is very coarse, dark-colored sandstone to a very massive gravelly rock, approaching the conglomerate stage. Underneath it is a gray to yellowish finer-grained sandstone, superimposed upon the shale series previously mentioned.

West of Waatch Strait to Cape Flattery, on the strait side, the formation is thin-bedded to massive, hard, iron-gray to rusty-brown slate and sandstone, and on the Pacific side it is mostly dark gray slates and thin-bedded sandsone, while in the central area and apparently forming the core of the promontory are coarse sandstones and gravelly and coarse conglomerates. The latter seem to be almost wholly made up of volcanic material. Whether the cementing material was volcanic also could not be determined. The bulk of the mass was mostly angular blocks, all of volcanic origin. There were volcanic bombs and basalt fragments that were easily recognized. The basalt fragments showed beyond doubt that they had been cooled on a land surface. Almost all had vesicular spaces, some of which are now filled with calcium carbonate. As the volcanic material of this region seems to have all been ejected in Eocene times, it is quite possible that the shales and sandstones to the westward of this conglomerate series will prove to be Eocene in age.

Note.—The finding of a fossil, *Thyasira bisecta* Con., on the Pacific front, as has been previously noted in a foot-note, shows that this formation rims the Quillayute synclinal trough.

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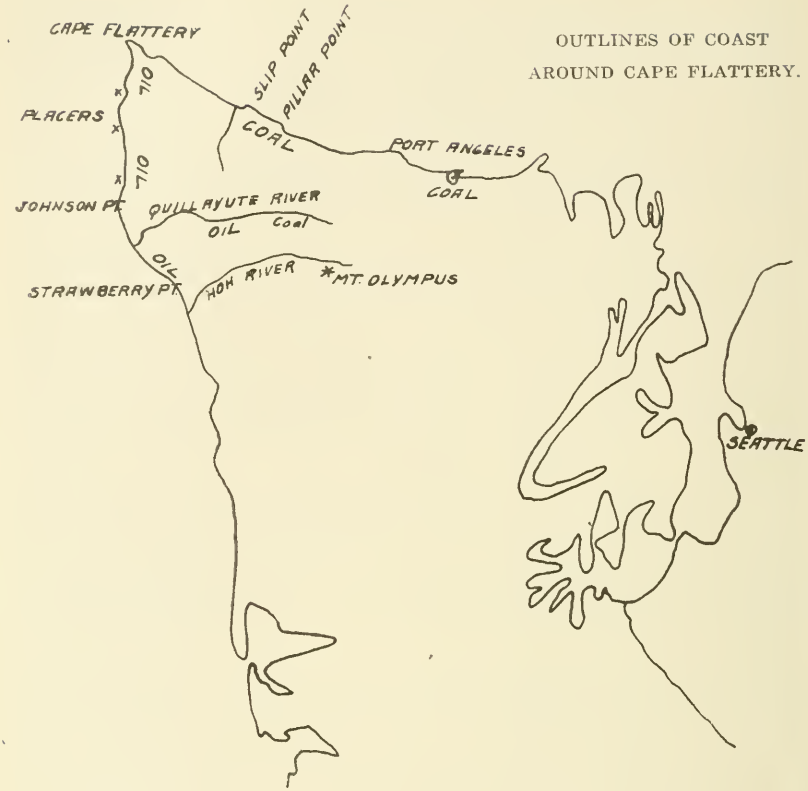
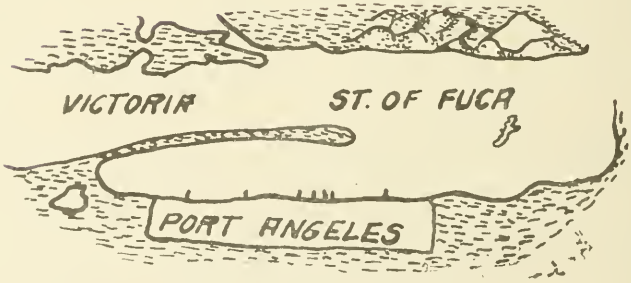
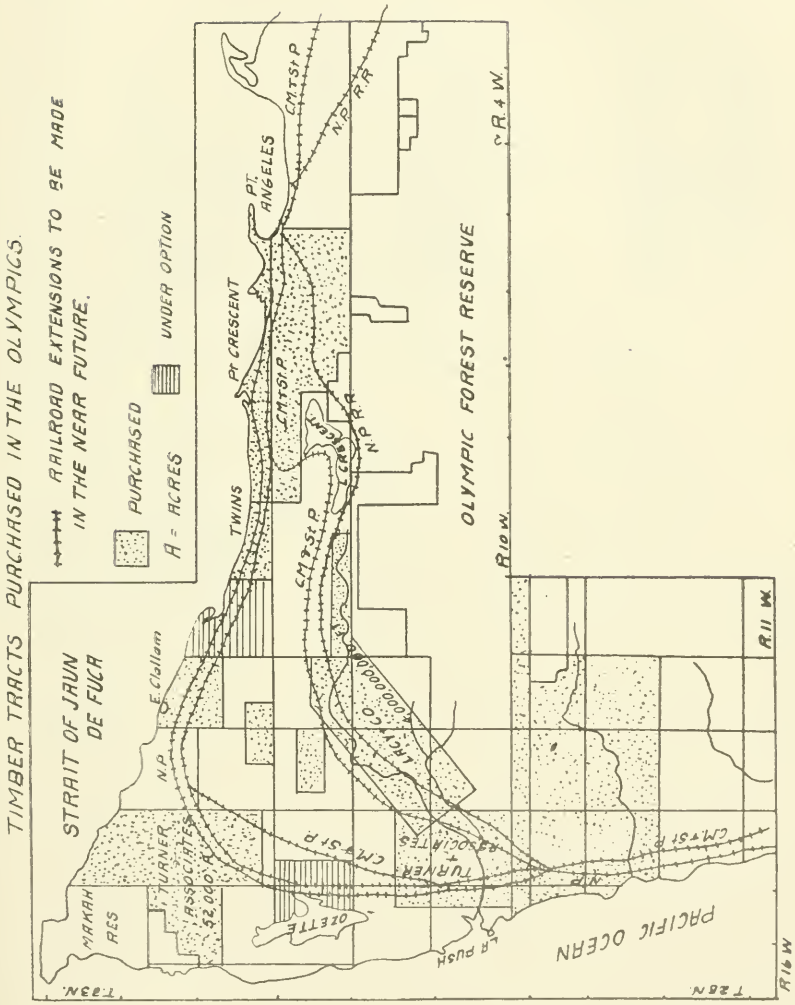
26. Merriam, Univ. Cal., Bull. Dept. Geol., vol. 2, No. 3, p. 102.

OUTLINES OF COAST AROUND CAPE FLATTERY.





HARBOR OF PORT ANGELES.


TIMBER TRACTS PURCHASED IN THE OLYMPICS.
RAILROAD EXTENSIONS TO BE MADE IN THE NEAR FUTURE.
PURCHASED
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A = ACRES
STRAIT OF JUAN DE FUCA
E. Clallam
N.P.
TURNER ASSOCIATES 52,000 A.
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PT. ANGELES
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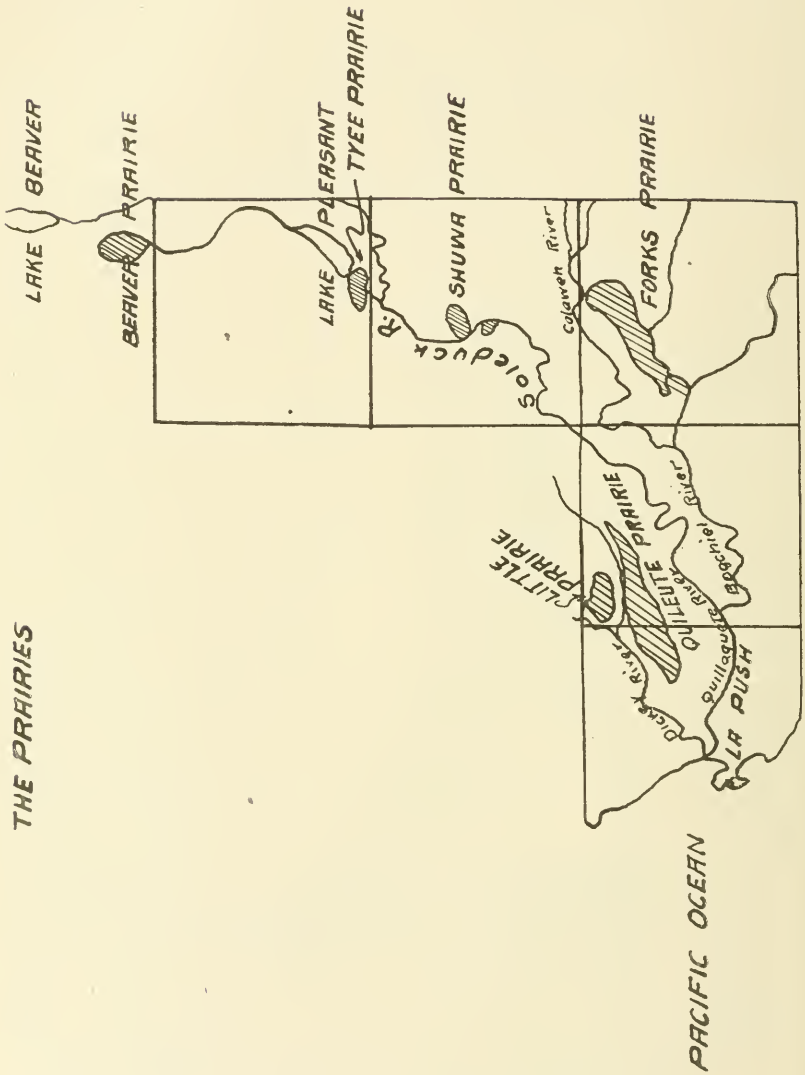
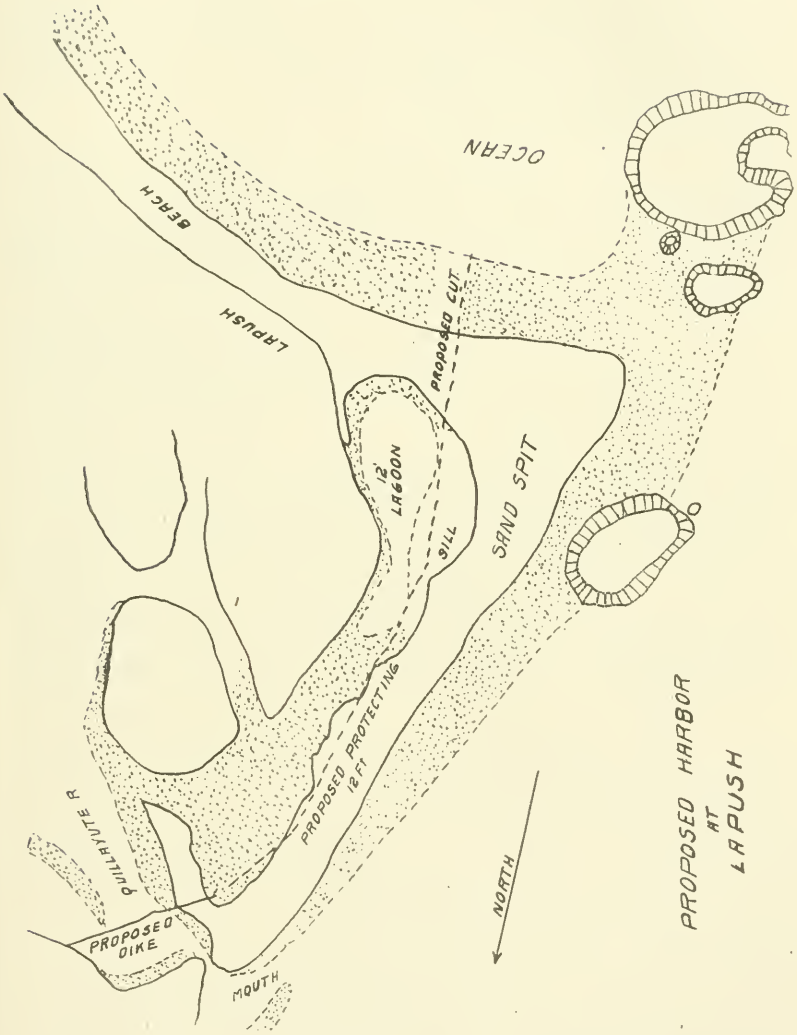
OLYMPIC FOREST RESERVE
LRC&C. CO. 600,000 A.
TURNER + ASSOCIATES
L. PUSH
PACIFIC OCEAN
T.23N.
T.28N.
R.16 W.
R.10 W.
R.11 W.



THE PRAIRIES


OCEAN
BEACH
LAPUSH
PROPOSED CUT
12' LAGOON
SILL
SAND SPIT
PROPOSED PROTECTING
12 FT
PUYALLUP R
PROPOSED DIKE
MOUTH
NORTH
PROPOSED HARBOR AT LAPUSH

FOSSILS FROM THE OLIGOCENE-MIOCENE OF WASHINGTON ON THE STRAIT OF JUAN DE FUCA.

So far as the writer can learn, these are the first fossils ever described from this region; and the only fossils so far described that resemble them are the Astoria (Oregon) fossils of Conrad,[27] and possibly those of the Sooke District, and of Carmanah Point of Vancouver Island.[28]

The arrangement of the species and the respective numbers of the families given are after Arnold.[29]

In this treatise, as in that of the Pliocene shells later, the measurements of the respective shells are given in millimeters, unless otherwise stated, and the number of the shell given in the plate is the number of the description of the same. All the shell drawings are natural size, unless otherwise stated. The illustrations are from drawings by my wife, Mrs. Otilla A. Reagan.

The locality from which each shell was obtained is stated in the description of that shell.

In submitting the shell descriptions, the writer wishes to thank Doctor Branner of Stanford University for the free use of the books of his large geological library; and especially the volumes of the Pacific Railroad Report and those of the Wilkes's Exploring Expedition; also Gabb's two volumes on the Palaeontology of California[30] and Mr. Ralph Arnold's Monograph on the Paleontology and Stratigraphy of the Marine Pliocene and Pleistocene of San Pedro, California.[31]

FOSSILS FROM THE CLALLAM FORMATION.

List of fossils obtained from the lower clay shales exposed near Gettysburg, Wash.:

Obtained by the writer.	*Obtained by Doctor Arnold.*[32]
Solemya ventricosa Conrad.	Solemya rubroradiata Conrad.
	Leda sp.
	Nucula sp
Yoldia impressa Conrad.	
	Pecten clallamensis Arnold.
	Pecten waylandi Arnold.
Thracia trapezoides Conrad.	

27. Am. Jour. Sci., vol. 55, 1848, pp. 432, 433, figs. 1-14; and Wilkes's Exploring Expedition, vol. X, pp. 722-730, pls. 17-20.

28. Univ. Cal. Geol., vol. 2, No. 3, pp. 101-108.

29. Mem. Cal. Acad. Sci., vol. III, 1903.

30. Pal. Cal., vol. I, 1864; vol. II, 1869.

31. Loc. cit.

32. Geol. Soc. Am., vol. 17, pp. 451-468, pls. 55-58, 1904.

Obtained by the writer.	*Obtained by Doctor Arnold.*
Phacoides acutilineatus Conrad.	Phacoides acutilineatus Conrad.
Venus (Chione) vespertina Conrad.	
Venus (Chione) angustifrons Conrad.	
Tellina albaria Conrad.	Tellina sp.
Mactra gibbsana Meek.	
Dentalium substriatum Conrad.	Dentalium substriatum Conrad.
	Fusus sp.
	Marginella or Erato sp.
	Natica sp.
Polynices (Neverita) reclusiana Petit.	
Polynices (Neverita) saxea Conrad.	
Polynices (Lunatia?) olympidii n. s.	
Cyrodes aff. dowelli White.	
	Perissolax sp.
Dolium petrosum Conrad.	
Dolium biliratum Conrad.	
Chrysodomus gettysburgensis n. s.	
Purpura canaliculata Ducal.	
	Aturia cf. ziczac Sowerby.
? Macrocystis cf. pyrifera?.	

List of fossils from the sandstone (upper) horizon of Gettysburg:

Obtained by the writer.	*Obtained by Doctor Arnold.*
Solemya ventricosa Conrad.	Solemya rubroradiata Conrad.
	Leda sp.
Nucula (Acila) castrensis Hinds.	
Nucula (Acila) gettysburgensis n. s.	Nucula sp.
Phacoides acutilineatus Conrad.	Phacoides acutilineatus Conrad.
	Cytherea cf. vespertina Conrad.
Venus (Chione) mathewsonii Gabb.	
Venus (Chione) temblorensis Anderson.	
Pellina albaria Conrad.	Tellina (Angulus) sp.
	Thracia cf. trapezoides Conrad.
Mactra gibbsana Meek.	
Dentalium substriatum Conrad.	
	Cylichna petrosa Conrad.
	Dolium petrosum Conrad.
	Fusus sp.
	Natica sp.
Polynices (Neverita) reclusiana Petit.	
Polynices (Neverita) saxea Conrad.	
Polynices (Lunatia?) olympidii n. s.	
Trochita inornata Gabb.	
Olivella pedroana Conrad.	
	Perissolax (?) sp.
	Pleurotoma sp.
	Scala sp.
?Macrocystis cf. pyrifera?.	

List of fossils from the lower horizon, exposed at East Clallam:

Obtained by the writer.	*Obtained by Doctor Arnold.*
Nucula (Acila) castrensis Hinds.	
Yoldia impressa Conrad.	
	Arca sp.
Phacoides acutilineatus Conrad.	
Venus (Chione) angustifrons Conrad.	Venus (Chione) aff. temblorensis Anderson.
Venus (Chione) olympidea n. s.	
Venus (Chione) clallamensis n. s.	
	Cytherea cf. vespertina Conrad.
Saxidomus gibbosus Gabb.	
	Pecten fucanus Dall.
	Pecten propatulus Conrad.
Tellina arctata Conrad.	Tellina arctata Conrad.
Tellina arctata, var. Juana, n. var.	
Tellina clallamensis, n. s.	
Mactra gibbsana Meek.	
Teredo sp.	
Teredo bulbosus n. s.	
Dentalium substriatum Conrad.	
	Fusus oregonensis Conrad.
	Natica sp.
Polynices (Neverita) saxea Conrad.	
Polynices (Lunatia?) olympidii n. s.	
	Sigaretus scopulosus Conrad.
Trochita inornata Gabb.	
Pisania clallamensis n. s.	
?Macrocystis cf. pyrifera?.	

List of fossils from the middle horizon exposed at East Clallam:

The fossils are found in a dark-colored slate (shale) and slaty sandstone to a very hard, dark-colored, massive sandstone, containing fragments of coal and charred wood; the color of the rock is due to its bituminous constituents:

Obtained by the writer.

Yoldia impressa Conrad.
Pectunculus patulus?.
Pecten (Chlamys) fucanus Dall?.
Pecten (Chlamys) wattsi, var. Morani Arnold?.
Pecten (Pantinopecten) propatulus Conrad?.
Venus (Chione) clallamensis n. s.
Tellina arctata Conrad.
Tellina clallamensis n. s.
Metis alta Conrad.
Mactra gibbsana Meek.
Dentalium substriatum Conrad.
Polynices (Neverita) saxea Conrad.
Sigaretus scopulosus Conrad.
?Macrocystis cf. pyrifera?.

List of fossils from near the top of the Clallam formation as exposed at East Clallam, Wash., in the vicinity of the lighthouse:

Obtained by the writer.	*Obtained by Doctor Arnold.*
	Chione aff. temblorensis Anderson.
Venus (Chione) clallamensis n. s.	
Tellina arctata Conrad.	Tellina sp.
Mactra gibbsana Meek.	Mactra sp.
	Mytilus aff. mathewsonii Gabb.
Panopea generosa Gould.	Panopea generosa Gould.
	Pecten fucanus Dall.
	Phacoides acutilineatus Conrad.
	Crepidula prærupta Conrad.
Dentalium substriatum Conrad.	Dentalium substriatum Conrad.
	Fusus sp.
	Scala (Opalia) sp.
Polynices (Neverita) saxea Conrad.	
Pisania clallamensis n. s.	
?Macrocystis cf. pyrifera?.	

List of fossils from the upper beds of the Cape Flattery section. Mr. Arnold's species are from the mouth of the Sekiu river; the fossils obtained by the writer are from a point on the coast five miles east of Neah Bay, Washington:

Obtained by the writer.	*Obtained by Doctor Arnold.*
	Cardium aff. quadrigenarium Conrad.
	Leda sp.
	Mactra sp.
	Nucula sp.
Nucula (Acila) gettysburgensis n. s.	
Yoldia impressa Conrad.	
	Yoldia sp.
Phacoides acutilineatus Conrad.	
Phacoides cf. nuttallii Conrad.	
Thyasira bisecta Conrad.	
	Tellina aff. bodegensis Hinds.
	Cancellaria sp.
	Cylichna sp.
	Dentalium sp.
	Fusus sp.
	Natica sp.

DESCRIPTION OF FOSSILS OBTAINED BY THE WRITER.

MOLLUSCA.

Class PELECYPODA; Order PRIONODESMACEA.
Family I SOLEMYACIDÆ; Genus *Solemya* Lam.

Shell Soleniform, equivalve, low-beaked, edentulous, gaping.

1. *Solemya ventricosa* Conrad. Plate I, fig. 1.

Solemya ventricosa Con. Wilkes's Expl. Exped., vol. X, p. 723, pl. 17, figs. 7–8.

Conrad's description:[33] "Oblong, ventricose; dorsal and ventral margins straight and parallel; anterior side narrowed, the margin orbiculate; posterior margin scalloped; the interior half truncated obliquely inward; beaks distant from the anterior extremity; lateral surface smooth, radiated with narrow bands."

This is a very common species in both the upper and lower series of the Oligocene-Miocene rocks at Gettysburg, Wash., but is most abundant in the upper series.

Miocene at Astoria Ore. (Conrad); Oligocene-Miocene, Gettysburg, Wash. (Reagan).

Superfamily NUCULACEA; Family VI NULULIDÆ; Genus *Nucula* Lamarck.

"Shell trigonal, with the umbones turned towards the short posterior side; smooth or sculptured; epidermis olive; interior pearly; margins crenulated; hinge with prominent internal cartilage-pit, and a series of sharp teeth on each side; pallial line simple. Type, *Arca nucleus* Lam." (Arnold.)

Subgenus *Acila* H. & A. Adams.

Shell with divaricate structure.

2. *Nucula* (*Acila*) *castrensis* Hinds. Plate I, fig. 2.

Nucula castrensis Hinds, Proc. Zool. Soc., 1843, p. 98; also, Hinds Voy. Sulphur, p. 61, pl. 17, fig. 5.

Nucula (*Acila*) *castrensis* H. & A. Adams, Genera. Rec. Moll., vol. 2, p. 545.

Nucula divaricata Con., Wilkes's Expl. Exped., vol. X, p. 725, pl. 18, fig. 6; also, Am. Jour. Sci. 1848, p. 432, fig. 1.

Nucula decisa Con., P. R. R. Rept., vol. V, p. 222, pl. 3, fig. 19.

Nucula conradi Meek, Smithsonian Check List (*fide* Gabb, Pal. Cal., vol. 11, 1869, p. 102).

Acila castrensis Hinds, Cooper, 7th Ann. Rept. Cal. St. Min., 1888, p. 227; Williamson, Proc. U. S. Nat. Mus., vol. XV, 1892, p. 192. Dall, Trans. Wagner Inst. Sci., vol. III, 1898, p. 572.

Acila lyalli Baird (*fide* Carpenter, Brit. Assn. Rept., 1863, p. 644).

Nucla (*Acila*) *castrensis* Hinds, Arnold, Mem. Cal. Acad. Sci., vol. III, pp. 95, 96.

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33. Loc. Cit.

Shell small, subovate to trigonal and subrhomboidal, convex, of medium thickness; beaks posterior to center, turned posteriorly: posterior end short, obliquely truncated; anterior end long, rounded: surface marked by divaricating striæ; hinge with numerous sharp teeth on each side and with prominent internal cartilage-pit.

This is a very variable species; its range covers the entire Tertiary series represented in this region, though it is rare in the Oligocene-Miocene formation along the Strait of Fuca. It is very abundant in the Quillayute Pliocene. Specimen figured is from the Quillayute formation.[34]

Living: Sitka to San Diego (Cooper); Puget Sound; Quillayute Bay (Reagan).

Pleistocene: San Pedro (Arnold); San Diego to Santa Barbara (Cooper; Gabb).

Pliocene: San Fernando (Gabb; Cooper); San Diego well (Cooper); San Pedro, Cal. (Arnold); Quillayute, Wash. (Reagan).

Miocene: Astoria, Ore. (Conrad; Cooper; Gabb); Martinez: Griswold's, San Benito county, California (Cooper).

Oligocene-Miocene: Blakely, near Seattle, Wash. (Arnold): Gettysburg, East Clallam, Wash. (Reagan).

3. *Nucula* (*Acila*) *gettysburgensis* n. s. Plate I, fig. 3.

Shell resembling *N.* (*Acila*) *castrensis* Hds. but much larger. Shell trigonal, convex, medium thickness; umbones considerably posterior to center, turned posteriorly, posterior end 16, anterior extremity 24.5 from umbones; posterior end short, truncated, concave back of umbones; anterior end rounded to arcuate, forming an acute angle with the anterior extremity; ventral and cardinal margins subparallel; lunule area large, slightly scooped out, sculptured same as rest of shell; a low ridge fronts each valve back of the lunule area, back of which there is a wide, flat, curved sinus extending from the umbo to the ventral margin, widening as it approaches that margin; surface divaricately sculptured, also ornamented with about seven concentric low ridges; inside of shell not seen.

Dimensions: Lat., 28; alt., 19.5.

The shell figured is from the Gettysburg formation.

This shell is easily distinguishable from *N. castrensis* Hds. by its larger size, more truncated, concave posterior extremity, large lunule, and by its umbones being placed more posteriorly; and

34. The specimens obtained from East Clallam possess a finer surface sculpture than those of the Quillayute formation.

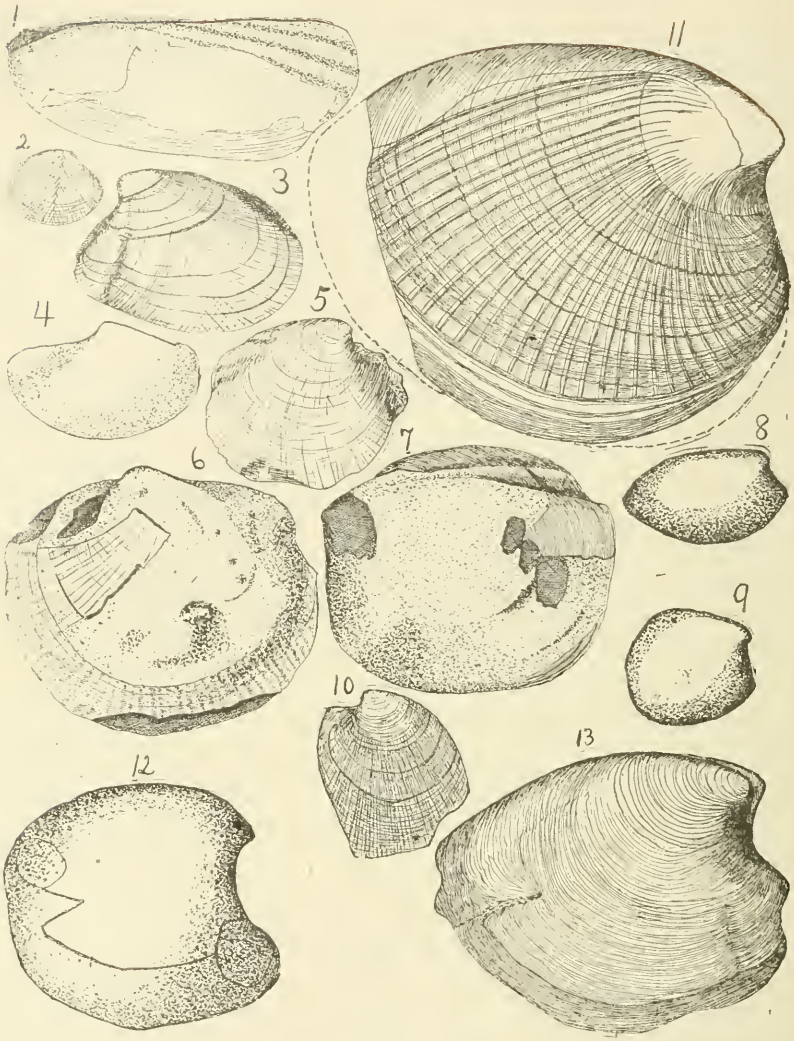

PLATE I.

FIG. 1. Solemya ventricosa Conrad.
FIG. 2. Nucula (Acila) castrensis H. & A. Adams; left valve.
FIG. 3. Nucula (Acila) gettysburgensis n. s.; left valve.
FIG. 4. Yoldia impressa Conrad; cast of right valve.
FIG. 5. Phacoides acutilineatus Conrad; a cast; times, one-half.
FIG. 6. Phacoides cf. nuttallii Conrad; a cast.
FIG. 7. Thyasira bisecta Conrad.
FIG. 8. Venus (Chione) vespertina Conrad; a cast; times, one-half.
FIG. 9. Venus (Chione) angustifrons Conrad; a cast; times, one-half.
FIG. 10. Venus (Chione) mathewsonii Gabb; a much broken specimen; times, one-half.
FIG. 11. Venus (Chione) temblorensis Anderson.
FIG. 12. Venus (Chione) olympidea n. s.; a cast.
FIG. 13. Venus (Chione) clallamensis n. s.; a cast.

from *N. truncata* Gabb by its size, its larger and more pronounced umbones, by the large concave area posterior to umbones, and by the low ridge on the posterior dorsal front of each valve, back of which extends the posteriorly curved sinus from umbo to ventral margin, and which continues to widen as it approaches the latter. It resembles some of the Japanese species, both living and Tertiary, very much, but has the beaks pitched and curved more backward.

Only two specimens were obtained from the upper series of the Clallam formation at Gettysburg, and one from the Neah Bay section of the same formation.

Genus *Yoldia* Möller.

"Shell oblong, slightly attenuated behind, compressed, gaping, smooth or obliquely sculptured, with a dark-olive shining epidermis; external ligament slight; cartilage as in *Leda*; pallial sinus deep. *Yoldia myalis* Couth. is a characteristic species." (Arnold.)

4. *Yoldia impressa* Conrad. Plate I, fig. 4.

Nucula impressa Con., Wilkes's Explo. Exped., vol. X, p. 726, pl. 18, fig. 7.
Yoldia impressa Meek, Sm. Check List, Miocene.
Yoldia cooperi Gabb (in part), Proc. Cal. Acad. Sci., 1865, p. 189.
Yoldia cooperii Cpr., Cooper (in part), Enumerations of West Coast Mollusca.

Conrad's description:[35] "Oblong ovate, convex, with regular concentric impressed lines. Anterior extremity rostrate, slightly recurved, extremity truncated; ligament-margin arcuate, slightly declining; rounded behind. Beaks submedial. Basil margin arcuate, slightly contracted near the anterior extremity."

The fine lines of the surface are neat, but closely crowded. The apical angle is about 160 degrees.

This species is very variable. The length varies from one to two and one-half inches; the breadth of the mature shells is usually about one-half inch.

The shells of this species are much more gibbous than the shells of *Yoldia cooperi*, and are also much shorter.

This species was found in the Gettysburg shales of the Oligocene-Miocene series; also in the lower and middle series of the same formation at East Clallam. The shells in the Gettysburg series were found to be larger than those obtained at East Clallam.

The shell figured is from the Gettysburg formation.

Miocene: Astoria, Ore. (Conrad); between Martinez and Monte Diablo, Cal.; Astoria, Ore. (Cooper; Gabb).

Oligocene-Miocene: Gettysburg, East Clallam, Wash. (Reagan).

35. Loc. cit.

Superfamily ARCACEA; Family VII ARCIDÆ.
Subfamily PECTUNCULINÆ; Genus *Pectunculus* Lam.

Pectunculus patulus?.

A much-worn specimen, apparently of this species, was obtained from the middle series of the Clallam formation as represented at East Clallam.

Superfamily PECTINACEA; Family IX PECTINIDÆ; Genus *Pecten* s. s.

4½ *a.* *Pecten* (*Chlamys*) *fucanus* Dall?.
4½ *b.* *Pecten* (*Chlamys*) *wattsi* var. *morani* Arnold?.
4½ *c.* *Pecten* (*Pantinopecten*) *propatulus* Con.?.

Only fragments of *Pectens*, doubtfully classed as above, were obtained at East Clallam, in the middle series there; no *Pectens* were found at any other horizon.

Order ANOMALODESMACEA; Superfamily ANATINACEA.
Family XIV THRACIIDAE; Genus *Thracia* (Leach) Blainville.

4½ *d.* *Thracia trapezoides* Conrad.

Thracia trapezoides Con., Wilkes's Expl. Exped., p. 723, pl. 17, fig. 6.

Conrad's description:[36] "Trapezoidal; ventricose; flank flattened, carinate; side anteriorly compressed; surface faintly concentric undulate and neatly but unequally marked with concentric striæ; beaks prominent, medial; posterior margin truncated: basal margin tumid at middle; casts have surface faintly concentric undulate; muscular impressions rather indistinct, the posterior quite small; pallial sinus large."

Only a fragment of a shell of this species was obtained in the Oligocene-Miocene shales near Gettysburg, Wash.

Miocene: Tomales, Cal. (Gabb).

Post-Pliocene: Astoria (Conrad); Eagle Prairie (Gabb).

Oligocene-Miocene: Gettysburg, Wash. (Arnold; Reagan).

Superfamily LUCINACEA; Family XXI LUCINIDÆ.
Genus (*Phacoides*) *Lucina* Brugiere.

Shell rounded, orbicular, convex, white; umbones depressed; lunule usually present and distinct; margins crenulated or smooth: ligament oblique, semi-internal; dentition usually normal, two hinge teeth in each valve, two lateral teeth in right valve, four in left; rugose muscular impressions; posterior extremity oblong; anterior elongated within the pallial line; umbonal area with a deep furrow. Characteristic species, *Lucina jamaicensis* Linne.

36. Loc. cit.

5. *Phacoides acutilineatus* Conrad. Plate I, fig. 5; times, one-half.

Lucina acutilineata Con., Wilkes's Expl. Exped., vol. X, p. 725, pl. XVII, fig. 2, 1849.

Cyclas acutilineata Con., Jour. Conch., 1865, p. 153.

Lucina borealis (not of Linne's Syst. Nat. Edition XII, p. 1413); of Carpenter, Brit. Assn. Rept., 1863, p. 643.

Pectunculus patulus Con., Jour. Conch., 1865, p. 153 (not Wilkes's Expl. Exped., p. 726, pl. XVIII, fig. 9).

Lucina tertica Con. (*fide* Gabb, Pal. Cal., vol. II, p. 100, 1869).

Lucina borealis of Cooper, 7th Ann. Rept. Cal. St. Min., 1888, p. 246.

Lucina acutilineata Con., Arnold, Mem. Cal. Acad. Sci., vol. III, pp. 131-132.

Phacoides acutilineatus Con., Arnold, Geol. Soc. Amer., vol. 17, pp. 463-464 (mentioned in list only).

Arnold's description:[37] "Shell large, orbicular, only slightly convex, rather thin; umbones depressed, central; surface ornamented by numerous equal, equidistant, sharp, raised, concentric lines; interspaces show lines of growth; lunule small, but deeply impressed and distinct; two sharp cardinal teeth in each valve; lateral teeth nearly obsolete; anterior muscle-impression much elongated."

Dimensions of largest specimen obtained: Lat., 70; alt., 60; diam., 26.

This species is very common in the Oligocene-Miocene strata of the region along the Strait of Juan de Fuca; the specimen here figured was obtained at East Clallam.

Living: Catalina Island (Cooper); Santa Barbara channel (Carpenter); Puget Sound (Arnold).

Pleistocene: Santa Barbara to San Diego, Cal. (Cooper); San Pedro, Santa Barbara, San Diego (Arnold).

Pliocene: Stanford University (Arnold); San Fernando, San Diego well, Santa Barbara, Santa Cruz, Santa Rosa, Sargent's, Santa Clara county, California (Cooper).

Miocene: Astoria and various other places in Oregon; Martinez, Orestima Cañon, Stanislaus county; Foxin's, Santa Barbara county; Griswold's, San Benito county, California (Cooper); Point Blakely, near Seattle, Wash. (Arnold).

Oligocene-Miocene: Gettysburg, East Clallam, Wash. (Arnold; Reagan); Neah Bay, Wash. (Reagan).

5½. *Phacoides nuttallii ?* Conrad.

A fragment of a shell containing the peculiar markings of this species was found in the Quillayute formation at the mouth of Maxfield creek.

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37. Loc. cit.

6. *Phacoides cf. nuttallii* Conrad. Plate I, fig. 6.

Only a cast was obtained. Shell small, orbicular, slightly convex; umbones depressed, small, central; surface marked by numerous concentric lines and radiating ridges.

Specimen obtained from the Oligocene-Miocene formation near Neah Bay, Wash. This is the cast figured in the plate.[38]

Family XXIII CRYPTODONTIDÆ; Genus *Thyasira.*

"Shell globular, posterior side furrowed or angulated; umbones much recurved; lunule short or indistinct; ligament usually and to a certain extent external, placed in a groove on the hinge line, and outside the hinge-plate; teeth altogether wanting." (Arnold.)

7. *Thyasira bisecta* Conrad. Plate I, fig. 7.

Venus bisecta Con., Wilkes's Expl. Exped., vol. X, p. 724, pl. XVII, figs. 10–10*a*, 1849.

Thyasira bisecta Con., Meek, Smithsonian Check List, Miocene Fossils, 1864.

Cyprina bisecta Con., Jour. Conch., 1865, p. 153.

Conchocele bisecta Con., Gabb, Pal. Cal., vol. II, p. 99, 1869.

Conchocele disjuncta Gabb, Pal. Cal., vol. II, pp. 28–29, pl. VII, fig. 48, 1869. Cooper, 7th An. Rept. Cal. St. Min., 1888, p. 236.

Cryptodon bisectus Con., Dall, Proc. U. S. Nat. Mus., vol. XV, 1892, p. 189; vol. XVII, 1894, p. 713, pl. XXVI, figs. 2–5.[39]

Thyasira bisecta Con., Arnold, Mem. Cal. Acad. Sci., vol. III, pp. 135–136, pl. XV, fig. 5.

Shell large, subquadrate, subrhomboidal, ventricose, convex, of medium thickness; anterior end very short, abruptly truncate, angulate below, with submarginal ventral furrow and the inferior margin at its termination slightly excavate; cardinal margin arched, sloping downwards towards the posterior end; surface strongly excavate from upper side of the beak to the posterior margin and subcarinate below the excavation; beaks terminal, anterior pointed forward; ligament long, elliptical, forming a regular curve with the supero-posterior margin; large lunular area in front of beaks; basal margin generally arcuate.

A single specimen was obtained in an exposure on the beach-front near Neah Bay on the Strait of Juan de Fuca.

Living: Puget Sound, sixty-nine fathoms (Dall).

Pliocene: San Pedro, Cal. (Arnold).

Miocene: Astoria, Ore. (Conrad); Blakely, near Seattle, Wash. (Arnold).

Oligocene-Miocene: Neah Bay, Wash.; on the Pacific coast, three and one-half miles south of the mouth of the Quillayute river, Clallam county, Washington (Reagan).

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38. A shell resembling *Phacoides annulatus* Reeve also occurs in this formation.

39. After Arnold, loc. cit.

Superfamily VENERACEA; Family XXVII VENERIDÆ.
Subfamily VENERINÆ; Genus *Venus* Linne.

"Shell thick, ovate, smooth, sulcated, or cancellated; margins minutely, crenulated; cardinal teeth, three in each valve; pallial sinus small, angular; ligament prominent; lunule distinct."

Subgenus *Chione* Megerle.

"Shell oval, triangular or subcordiform; margins finely crenulated; hinge narrow, solid, with three teeth in the right valve and two in the left, the interior tooth longest; ligament narrow; pallial sinus shallow. *Venus gnidia* Brod. is a characteristic species."[40]

8. *Venus* (*Chione*) *vespertina*, Conrad. Plate I, fig. 8; times, one-half.
Cytherea vespertina Con., Am. Jour. Sci., 1848, p. 432, fig. 9.
Dione vespèrtina Con., Jour. Conch., 1865, p. 152.

Conrad's description:[41] "Acutely ovate, ventricose, very inequilateral; summits prominent; surface with concentric lines which are not very smooth and regular; posterior side somewhat cuneiform; anterior extremity acutely rounded; basal margin rounded."

The cast of a single specimen was obtained from the lower shales near Gettysburg.

Miocene: Oregon (Conrad).

Oligocene-Miocene: Gettysburg, Wash. (Reagan).

9. *Venus* (*Chione*) *angustifrons* Conrad. Plate I, fig. 9; times one-half.
Venus angustifrons Con., Wilkes's Expl. Exped., vol. X, p. 724, pl. 17, fig. II.
Dione angustifrons Con., Jour. Conch., 1865, p. 152.

Conrad's description:[42] "Subtrigonal, ventricose; ligament margin very oblique and slightly curved; long posterior margin direct, truncate; basal margin arcuate; latter surface everywhere convex, and having thin, concentric, elevated lamellæ."

Specimen figured is a cast from the lower shales at Gettysburg, Wash., the only specimen obtained, except one which was found in the lower series at East Clallam.

Miocene: Astoria, Ore. (Conrad).

Oligocene-Miocene: Snohomish, Wash. (Arnold); East Clallam, Gettysburg (Reagan).

10. Venus (*Chione*) *mathewsonii* Gabb.

Chione mathewsonii Gabb., Pal. Cal., vol. *II*, p. 23, 1869. Plate I, fig. 10; times, one-half.

Shell large, very thick, subcordiform to subtriangular and obliquely cordate; beaks small, pointed forward and placed well an-

40. Arnold, loc. cit., pp. 146, 147.
41. Am. Jour. Sci. above.
42. Wilkes's exped. above.

teriorly; cardinal margin sloping rapidly but slightly convex; base broadly rounded; surface sculptured by numerous frills and numerous fine, crowded, radiating lines; interior of valve not seen.

Classification made by comparing specimens with specimens in the museum of the Leland Stanford Junior University.

The shells obtained differ from *C. mathewsonii* Gabb in that Gabb's shell lacks the sculpture.

Dimensions of largest specimen obtained: Length, 78; alt., 60.

The specimens were obtained from the lower Pliocene at Quillayute, Wash., in which formation they seem to be rare. A much-broken specimen was also found in the upper series of the Oligocene-Miocene formation at Gettysburg.

Specimen figured is from the Quillayute formation.

Miocene (?) of California (Gabb).

Upper Pliocene: Capitola, Cal. (Arnold).

Lower Pliocene: Quillayute, Wash. (Reagan).

Oligocene-Miocene: Gettysburg, Wash. (Reagan).

11. *Venus* (*Chione*) *temblorensis* Anderson. Plate I, fig. 11.

Venus (*Chione*) *temblorensis* Anderson, Cal. Acad. Sci., 3d ser., Geol., vol. II, No. 2, p. 196.

Anderson's description:[43] "Shell subtriangular in outline; beaks slightly incurved; lower margin rounded; hinge margin rather straight; surface ornamented with concentric ridges and radiating ribs, the ridges rising in gently fluted and ruffled folds."

Dimensions: Lat., 55; alt., 52.

The specimen figured was obtained from the upper series of the Clallam formation at Gettysburg, Wash., the only specimen of this species obtained.

Lower Miocene: Beds of Kern river and Temblor, California (Anderson).

Upper Oligocene-Miocene: Gettysburg, Wash. (Reagan).

12. *Venus* (*Chione?*) *olympidea* n. s. Plate I, fig. 12.

Description from a cast: Specimen medium-sized, suboval, convex to gibbous; surface ornamented with fine to coarse concentric lines of growth (judging from a few small fragments of the shell); beaks large, high, anterior, terminal, pointed forward; lunule area large; hinge robust; posterior muscular impression deep, circular; pallial sinus deep, small, triangular; pallial line deep, continuous.

Dimensions: Lat., 37; alt., 37.5; diam., 27.5; from beak to posterior extremity, 37; to anterior extremity, 21.

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43. Loc. cit.

This species differs from the other *Venus* species obtained in its short, robust, gibbous shape.

The specimen described is from the lower series at East Clallam; it is the only specimen of the species found.

13. *Venus* (*Chione*) *clallamensis* n. s. Plate I, fig. 13.

Shell ovate to subtriangular in outline; beaks considerably anterior to center, incurved; lower margin rounded to subarcuate in old specimens; posterior margin produced to an angle; hinge margin straight; surface ornamented with radiating ribs and concentric ridges (shown on a fragment of the shell); ribs flat, some very fine, others much thickened, formed by the coalescing of two or more smaller ones; ribs coalesce towards the beak, or to proceed from beak toward the base they may be said to be dichotomous; concentric ridges not flattened or ruffled; the concentric ridges show impressions on the casts.

Dimensions of largest specimen obtained: Length (2 inches) 52; alt. (1.8 in.) 48; from apex of umbones to posterior extremity, 52; to anterior extremity, 25; from posterior to anterior extremity, following the base-line, 58. Of a medium-sized specimen: L. (1.75 in.) 45; alt. (1.56 in.) 40; thickness (0.89 in.) 22; from apex of umbo to posterior extremity, 43; to anterior extremity, 22. Of a third specimen: L. (1.5 in.) 38; alt. (1.25 in.) 35; from apex of umbones to posterior extremity, 35.5; to anterior extremity, 22.

Measurements of Mr. Anderson's type specimen of *V.* (*Chione*) *temblorensis* were as follows: "2½ inches in larger diameter, and thickness 2½ inches."[44]

Distinguishable from *V.* (*Chione*) *temblorensis* Anderson by more anterior beaks, dichotomous ribs, the coalescing of some of the ribs and the variableness in the size of the same, and in the shells being less gibbous.

Shell found in all three horizons at East Clallam.

Subfamily TAPETINÆ; Genus *Saxidomus* Conrad.

Shell transversely oval, inequilateral, solid, ventricose; without lunule; umbones tumid; teeth three or four, inequal, narrow, central one bifid; ligament very thick, elongated; muscular impressions oval or rounded, nearly equal; pallial sinus large, elongated. *Saxidomus nuttallii* Con. is the type. (After Arnold.)

44. Anderson, Cal. Acad. Sci., Geol. 3d ser., vol. II, No. 2, p. 196.

14. *Saxidomus gibbosus* Gabb. Plate II, fig. 14.

Saxidomus gibbosus Gabb, Pal. Cal., vol. II, p. 58, pl. 16, fig. 18*a-b*, 1869.

Description from cast: Shell subquadrate, very inequilateral: beaks anterior, nearly terminal; anterior end excavated above, narrowly rounded below: posterior end convexedly subtruncated, sometimes, too, a little obliquely truncated; base broadly rounded; cardinal margin gently sloping and slightly convex; a few fragments of the shell show faint lines of growth; inside of shell not seen.

The specimen figured was the only one obtained. It is from the lower shales at East Clallam.

Pliocene: Eagle Prairie, Humboldt county, California (Gabb).

Oligocene-Miocene: East Clallam, Wash. (Reagan).

Superfamily TELLINACEA; Family XXX TELLINIDÆ.
Genus *Tellina* Linne.

Shell more or less elongated; rostrum more or less twisted; two lateral teeth in each valve.

15. *Tellina albaria* (Conrad). Plate II, fig. 15.

Tellina albaria Con., Wilkes's Expl. Exped., vol. X, p. 725, pl. 18, fig. 5.

Shell small, more or less compressed, thin, subtriangular; beaks submedial; anterior extremity obtusely rounded to angulate; posterior end regularly rounded; ventral margin straight at middle: surface practically smooth in young specimens but marked with concentric lines of growth in the older specimens, somewhat strongly in the very old; the shells become more gibbous with age.

Dimensions of a young specimen: Lat., 24; alt., 16; diam., 5. Dimensions of an adult specimen—the specimen figured: Lat., 31: alt., 22; diam., 13.

This species is very common in the Gettysburg shales, also in the sandstone of the upper series at Gettysburg.

Miocene: Astoria, Ore. (Conrad).

Oligocene-Miocene: Gettysburg, Wash. (Reagan).

16. *Tellina arctata* Conrad. Plate II, fig. 16*a*, 16*b*.

Tellina arctata Con., Wilkes's Expl. Exped., vol. X, p. 725, pl. 18, fig. 3; equals *Macoma arctata* Con., Gabb, Pal. Cal., vol. II, 1869.

Shell subelliptical, oblong, compressed; anterior extremity truncate and slightly sinuous, reflected below; basal margin elliptical to arcuate; ligamental margin declining; posterior margin rounded: surface marked by very faint, closely and regularly arranged concentric lines, most of which are obsolete on the worn specimens at hand; beaks small, pointed, and placed nearest the anterior extremity; interior of valve not seen.

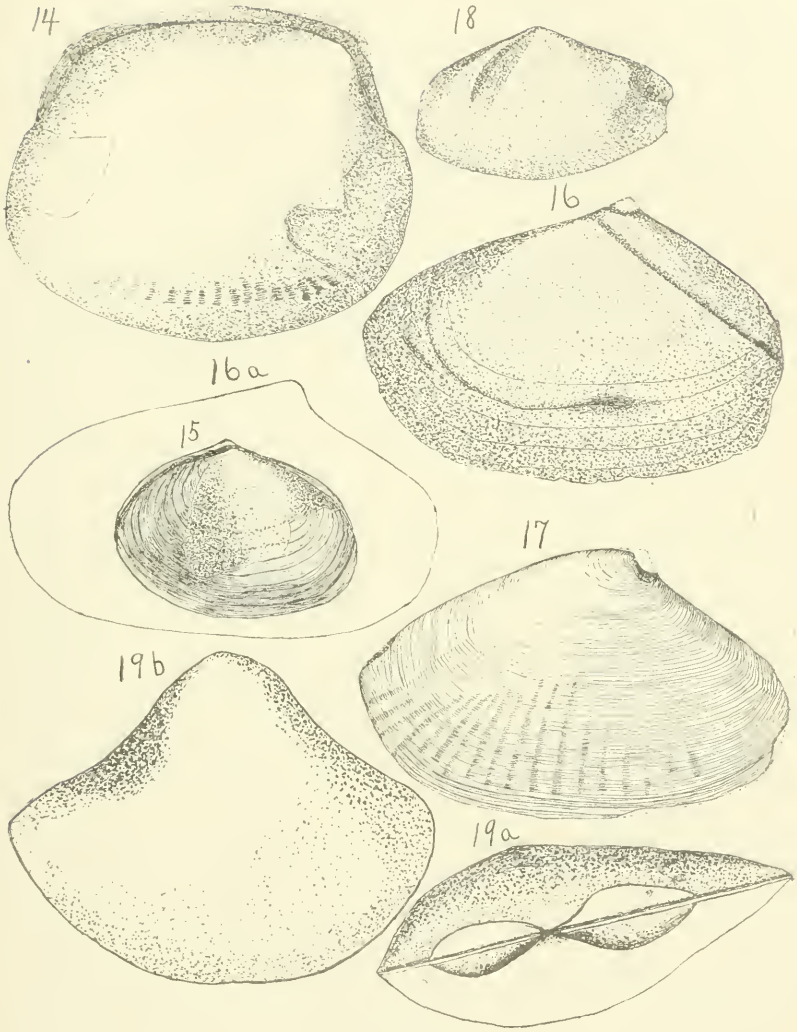

PLATE II.

FIG. 14. Saxidomus gibbosus Gabb; a cast.
FIG. 15. Tellina albaria Conrad.
FIG. 16. Tellina arctata Conrad; a cast.
FIG. 16*a*. Outline of another specimen of the same species.
FIG. 17. Tellina arctata; var. juana n. var.
FIG. 18. Tellina clallamensis n. s.; a cast.
FIG. 19*a*. Mactra gibbsana Meek; hinge view of cast.
FIG. 19*b*. Same specimen as 19*a*; side view.

Dimensions of an average specimen: Length, 50; alt., 35; diam., 16.

The specimens obtained are very variable. So far they have been found only at East Clallam in this region, and principally in the lower horizon there.

Miocene: Astoria, Ore. (Conrad).

Oligocene-Miocene: East Clallam, Wash. (Arnold; Reagan).

17. *Tellina arctata*, var. *juana* n., var. Plate I, fig. 17.

Shell like *Tellina arctata* Con., except ornamented with transverse bands in addition to the faint, closely and regularly arranged concentric lines shown on that species.

Only a single specimen of this variety was obtained from the lower series of the Oligocene-Miocene at East Clallam.

18. *Tellina clallamensis* n. s. Plate II, fig. 18.

Shell somewhat resembling *Tellina bodegensis*, but smaller and thinner.

Shell elongated, elliptical to narrow ovate, compressed, thin; umbones anterior to center, pointed posteriorly; anterior portion of shell almost evenly rounded; posterior dorsal margin slightly depressed back of umbo; posterior extremity obliquely truncate, straight from depressed margin back of umbo, front reflected; inferior margin arcuate to almost straight in some specimens; cardinal teeth not seen; pallial sinus long and thickened anteriorly (?) (only a faint impression seen); anterior muscle-impression on right valve large; ridge in front of impression extends nearly to umbo; posterior muscle-impression in same valve is also surrounded by a rather high ridge which extends nearly to the umbonal regions; the same is true of the muscle-impressions in the left valve. A fragment of unworn shell shows the surface to be marked with fine, regular, closely arranged concentric impressed lines.

Dimensions: Lat., 35; alt., 21; from umbo to posterior extremity, 23; to anterior extremity, 20; length of anterior "muscle-ridge," 14.

This shell can be distinguished from *T. bodegensis* by its being smaller and thinner, by its umbones being placed anterior to center, and by the thickened areas (ridges) on the inner-shell side of the muscular impressions being larger, longer and extending farther toward the umbonal region (a shell of a living *T. bodegensis* at hand gives this ridge as only 8.5 and distant from the apex of umbo 14.5 at dorsal end).

This is a very abundant species in the middle series at East Clallam, and is Oligocene-Miocene in age.

Genus *Metis* H. & A. Adams.

Shell slightly inequivalve, suborbicular, compressed; valve sillonated; posterior flexuosity submedian; no lateral teeth. A characteristic species is *Tellina meyeri* Phil.

18½. *Metis alta* Conrad.

Only the impression of the shallower valve with the angular groove was obtained, but enough to determine the species.

Specimen obtained from the middle series at East Clallam.

Superfamily MACTRACEA; Family XXXV MACTRIDÆ.
Subfamily MACTRINÆ; Genus *Mactra* Linne.

Shell nearly equilateral; anterior hinge tooth A-shaped; lateral tooth doubled in right valve; ligament and resilum separated by a shelly partition; cardinals generally coalescent above; laterals generally smooth, occasionally granular.

Type, *Mactra stultorum* Linne.

19. *Mactra gibbsana* Meek. Plate II, figs. 19*a*, 19*b*.

Matra gibbsana Meek, 1861, Proc. Acad. Nat. Sci. Phil., vol. XIII, p. 315; Bull. U. S. Geol. & Geogr. Surv. Terr., vol. II, No. 4, p. 374, pl. 2, figs. 8, 8*a–b*, 1876.

Meek's description (see Geol. & Geogr. Terr. above): "Shell transversely oval, or subtrigonal, moderately convex, rather thin; anterior side narrowly rounded; base forming a regular semi-elliptical curve; posterior side slightly truncated at the immediate extremity, abruptly rounded or subangular at its connection with the base below; dorsal outline sloping from beaks in front and behind at an angle of about 120 degrees; beaks central, rather elevated, but small and not projecting much above the hinge margin; surface marked only by moderately distinct lines of growth; posterior muscular impression oval, well defined; pallial line distinct and provided with a rather deep, horizontal sinus which is about one-third longer than wide."

This species is very abundant in all the series of the Clallam formation exposed along the Strait of Fuca, but most abundant in the lower series at East Clallam.

Dimensions: Length, 55; alt., 41; diam., 24.

Cretaceous or Tertiary(?): Float in Strait of Juan de Fuca (Meek).

Oligocene-Miocene: Gettysburg, East Clallam, Wash. (Reagan).

Superfamily MYACEA; Family XXXVIII, SAXICAVIDÆ.
Genus PAOPEA Menard.

Shell large, thick, equivalve, oblong, gaping widely behind and slightly in front; ligament external, on prominent ridges; an ob-

scure, sometimes prominent, tooth in each valve; pallial sinus deep; surface concentrically or feebly sculptured. *Mya glycymeris* Born. is a characteristic species.

20. *Panopea generosa* Gould. Plate III, fig. 20.

Panopea generosa Gld., Proc. Bost. Soc. Nat. Hist., vol. III, 1850, p. 215. Wilkes's Expl. Exped., vol. XII, p. 385, pl. XXXIV, fig. 507, 1852.

Glycymeris generosa Gld., H. & A. Adams, Gen. Rec. Moll., p. 350, 1853. Carpenter, Brit. Assn. Rept., 1863, p. 637. Gabb, Pal. Cal., vol. II, p. 89, 1869. Cooper, 7th Ann. Rept. Cal. St. Min., 1888, p. 241. Keep, West Coast Shells, p. 209, fig. 178, 1892. Williamson, Proc. U. S. Nat. Mus., vol. XV, 1892, p. 183. Dall, Wagner Inst. Sci., vol. III, part 4, 1898, p. 830.[45]

Panopea generosa Gld., Arnold, Mem. Cal. Acad. Sci., vol. III, pp. 182, 183.

Shell large and ponderous, rather thin, somewhat quadrilateral in adult specimens; the basal and hinge margins are parallel and straight in adult specimens; posterior extremity broadly truncated, somewhat obliquely; anterior extremity broadly rounded; anteriorly the shell gaps slightly and the valves are somewhat everted; surface coarsely undulating concentrically; beaks sharp and prominent and placed slightly anterior; anterior umbonal slope tumid; posterior slope a little compressed; hinge rather slender, with a single, erect, obliquely triangular tooth in each valve; ligament external; pallial sinus wide and shallow; posterior muscular scar but little broader than the pallial impressions; siphonal sinus shallow, small.

Dimensions of largest specimen obtained: Length, 86; alt., 49; diam., 26.

Living: Puget Sound to San Diego, Cal. (Dall); Neah Bay, Quillayute Bay, Wash. (Reagan).

Pleistocene: San Pedro (Arnold); Santa Barbara to San Diego, Cal. (Cooper).

Pliocene: San Fernando, Santa Barbara (Cooper); Santa Barbara, San Pedro (Arnold); Quillayute, Wash. (Reagan).

Oligocene-Miocene: Upper horizon, East Clallam, Wash. (Reagan).

This species is rare both in the Pliocene and in the Oligocene-Miocene formations.

The specimen figured is from the Upper horizon, East Clallam.

Superfamily ADESMACEA; Family TEREDINIDÆ; Genus *Teredo* Linne.

21. *Teredo* sp. Plate III, fig. 21.

A float-rock found near East Clallam contained many tubes of a small *Teredo*, but the species could not be determined.

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45. After Arnold, loc. cit.

22. *Teredo bulbosus* n. s. Plate III, fig. 22.

"Cast" of large size, cylindrical, and characterized by having bulbs or nodes on it at frequent intervals.

Specimen obtained from the lower series at East Clallam; formation, Oligocene-Miocene.

Class SCAPHOPODA; Order SOLENOCONCHIA.
Family XL BENTALIIDÆ; Genus *Dentalium* Linne.

Shell tube-like, tapering, with strong longitudinal ribs and with apical notch short or wanting.

23. *Dentalium substriatum* Conrad. Plate III, fig. 23.

Teredo substriata Con., Wilkes's Expl. Exped., 1850, p. 728, pl. 20, fig. 7.
Dentalium substriatum Woodw., Brit. Assn. Rept., 1856.
Dentalium substriatum Con., Jour. Conch., 1865, p. 151.

Shell nearly straight, cylindrical, very slightly tapering.

Fragments of this shell are found throughout the entire fossil-bearing sections of the Clallam formation.

Miocene: Astoria, Ore. (Conrad; Gabb).

Oligocene-Miocene: Gettysburg, East Clallam (Arnold; Reagan).

Class GASTROPODA; Superorder STREPTONEURA.
Order CTENOBRANCHITA; Superfamily TOXOGLOSSA.
Family LIV OLIVIDÆ; Genus *Olivella* Swainson.

Shell small, cylindrical, polished; spire produced, acute; suture canaliculated; aperture narrow behind; somewhat enlarged anteriorly; columella plicated in front, callous posteriorly; canal very short. *Olivella biblicata* Sowerby is a characteristic species.

24. *Olivilla pedroana* Conrad. Plate III, fig. 24.

Strephona pedroana Con., Pac. R. R. Rept., vol. V, p. 327, pl. VI, fig. 51, 1854.

Olivella boetica Carpenter, Brit. Assn. Rept., 1863, p. 661. Gabb, Pal. Cal., vol. II, p. 75, 1869. Tryon, Man. Conch., p. 71, pl. XVII, figs. 28, 31, 34, 1883. Cooper, 7th Ann. Rept. Cal. St. Min., 1888, p. 225. Keep, West Coast Shells, p. 42. fig. 21, 1892. Williamson, Proc. U. S. Nat. Mus., vol. XV, 1892, pl. XIX, fig 7.[46]

Olivella pedroana Con., Arnold, mem. Cal. Acad. Sci., vol. III, pp. 220, 221, 1903.

Shell small, elongate-elliptical; spire elevated, conical, about equal in height to the aperture; aperture elongate-triangular; columella not seen.

The shell is distinguishable from *O. intorta* by its slender form, smaller size and more elevated spire.

A single specimen of this species was found in the upper series of the Clallam formation at Gettysburg. It is an abundant species in the Pliocene of the Quillayute formation.

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46. After Arnold, loc. cit.

Living: Strait of Fuca to San Diego, Cal. (Cooper).

Pleistocene: Santa Barbara to San Diego, Cal. (Cooper); San Pedro, Los Cerritos, Spanish Bight and Pacific Beach, San Diego, at Barstow's ranch, Ventura (Arnold).

Pliocene: Kirker's Pass, San Diego well, Twelve Mile House, Seven Mile Beach, Cal. (Cooper); San Pedro, Cal. (Arnold); Quillayute, Wash. (Reagan).

Oligocene-Miocene: Gettysburg, Wash. (Reagan).

Specimen figured is from the Quillayute formation.

Family LVII FASCIOLARIIDÆ; Subfamily, FUSINÆ; Genus *Pisiana* Bivona.

"Shell oblong; spire prominent; whorls smooth or spirally striated; canal very short; outer lip thickened and crenulated. *Pisiana pusio* Linne is a characteristic species." (Arnold.)

25. *Pisiana clallamensis* n. s. Plate III, fig. 25.

Shell of medium size, biturbinate to fusiform; spire broadly conical, elevated; whorls five or six (top of spire broken), angularly ventricose; three low angular ridges revolve on each whorl—one just in front of the suture, its posterior slope joining the suture, and two on the body of the whorl, with a somewhat wide band between them; upper side of volutions obliquely sloping; lower side rounded; surface ornamented with very fine, revolving lines; suture distinct; aperture oval-pyriform: outer lip thick; umbilicus perforate.

Dimensions: Height of body whorl and first whorl of spire, 35: height of body whorl, 30; lat. of body whorl, 23; aperture, 22 x 14.

This species is found in the Oligocene-Miocene in both the upper and lower series at East Clallam. The specimen figured is from the lower series.

Family LVIII BUCCINIDÆ; Genus *Chrysodomus* Swainson.

Shell fusiform, elongate-ovoid, inflated, sometimes sinstral; spire elevated; whorls rounded; apex papillary; aperture oval; canal short, sometimes bent; inner lip simple, smooth.

26. *Crysodomus gettysburgensis* n. s. Plate III, fig. 26.

Shell much broken, large, fusiform; spire elevated; whorls sharply angulated, forming an unkeeled spiral table; surface unornamented; aperture pyriform; inner lip incrusted; canal curved backwards.

Demensions: Lat. of body whorl, 38; of next whorl, 24; alt. of body whorl, exclusive of canal, 39; of next whorl, 13.

This species differs from *C. tabulatus* Baird in its larger size, in

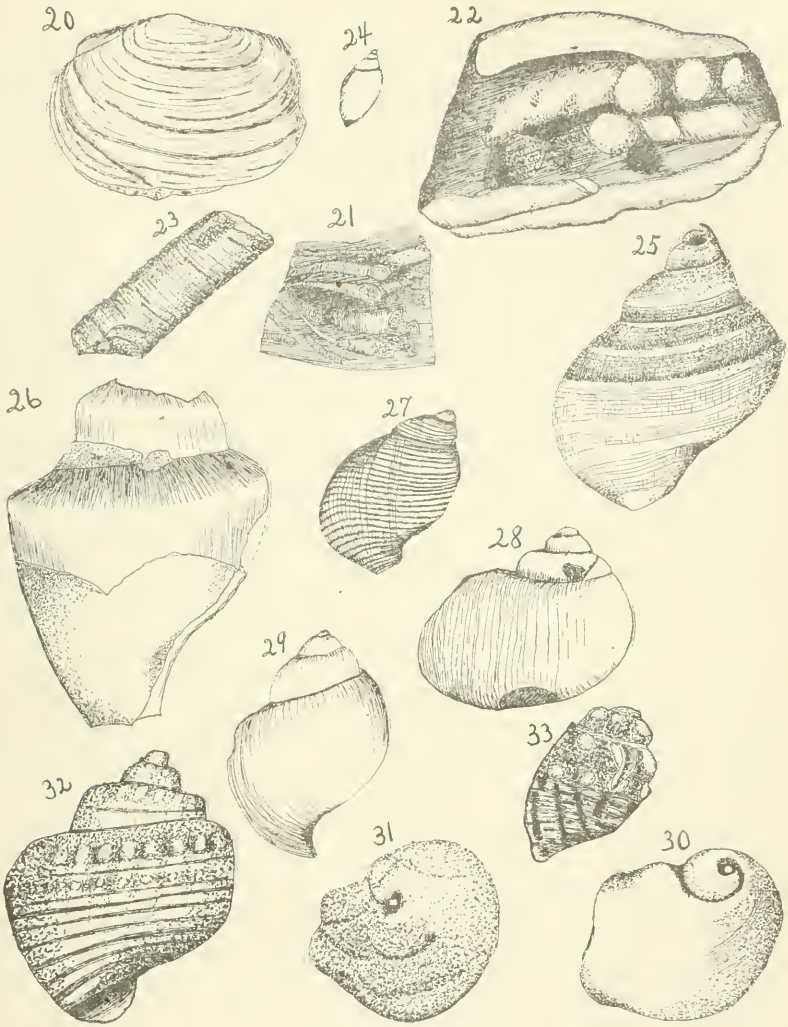

PLATE III.

FIG. 20. Panopea generosa Gould; times, one-half.
FIG. 21. Teredo species.
FIG. 22. Teredo bulbosus n. s.
FIG. 23. Dentalium substriatum Conrad.
FIG. 24. Olivella pedroana Conrad.
FIG. 25. Pisana clallamensis n. s.
FIG. 26. Chrysodomus gettysburgensis n. s.; a broken specimen.
FIG. 27. Purpura canaliculata Ducal; a somewhat distorted specimen.
FIG. 28. Polynices (Neverita) reclusiana Petit; times, one-half.
FIG. 29. Polynices (Lunatia?) olympidea n. s.
FIG. 30. Sigaretus scopulosus Conrad.
FIG. 31. Trochita inornata Gabb.
FIG. 32. Dolium petrosum Conrad; times, one-half.
FIG. 33. Dolium bileratum Conrad; a much distorted specimen.

its tabular area not being keeled and in its lack of sculpture. It differs from *C. giganteus* (described later) in its smaller size and in its not possessing the double tabular area and the keeled ridges bordering the respective tabular areas. A single specimen was obtained from the lower shales of the Oligocene-Miocene formation near Gettysburg, Wash.

Family LXI MURICIDÆ; Subfamily PURPURINÆ; Genus *Purpura* Brugiére.

Shell imperforate, oblong-oval, last whorl large with transverse ribs or nodes; spire generally short; aperture oval to ovate, large, terminating in a very short oblique channel, or notched; columella flattened, smooth; outer lip simple. *Purpura persica* Linne is a characteristic species.

27. *Purpura canaliculata* Ducal. Plate III, fig. 27.

Purpura canaliculata Ducal, An. N. Sc., 1832, p. 104, pl. LI, fig. 1 (equals *P. lima* Martyn).

Shell small, semiglobular; spire somewhat elevated; whorls four; suture impressed distinct; body whorl ventricose; aperture elliptical, large; inner lip flattened; canal short; outer lip thin; surface ornamented with spiral ridges and fine incremental lines (mostly worn off the specimens at hand).

Specimens of this species were found in the Gettysburg shale of the Clallam formation, but were rather rare; in the Upper Pliocene of the Quillayute formation, however, they are abundant. The specimens from the Clallam formation, however, have a larger body whorl than the more recent specimens.

This species is easily distinguishable from *P. crispata* by its larger body whorl in proportion to its axial length, and also by its smoother surface and by its smaller spire.

Measurements of a specimen from the clay shales of the Clallam formation of Gettysburg, Wash.: Axial length, 26; diam. 22; canal, 18 x 14.

Living: Alaska to San Diego (Cooper); Neah Bay, Quillayute Bay (Reagan).

Pliocene: Santa Rosa, Kirker's Pass, San Fernando, Cal. (Arnold); Quillayute, Wash. (Reagan); Queets, Wash. (Arnold).

Post-Pliocene: Santa Barbara (Gabb).

Oligocene-Miocene: Gettysburg, Wash. (Reagan).

The specimen figured is from the Quillayute formation.

Superfamily CERITHIACEA; Family LXXVII NATICIDÆ.
Genus *Polynices* Montfort.

All Naticida with corneous opercula. *Natica mammilla* is the type.

Subgenus *Neverita* Risso.

"Shell depressed, orbicular; spire conical or flattened; columella partly filled by a tongue-shaped callous process (funiculum) from the columella. *Natica duplicata* Say is a characteristic species."[47]

28. *Polynices* (*Neverita*) *recluziana* Petit. Plate III, fig. 28; times, one-half.

Natica recluziana Petit, Deshayes, Mag. de Zoöl., Mollusca, p. 37, 1841. Tryon, Man. Conch., vol. VIII, p. 34, pl. XII, fig. 1, 1886.

Neverita recluziana Petit, H. & A. Adams, Gen. Rec. Moll., vol. I, p. 208, 1853. Carpenter, Brit. Assn. Rept., 1863, p. 661. Cooper, 7th Ann. Rept. Cal. St. Min., 1888, p. 254. Keep, West Coast Shells, p. 46, fig. 26, 1892. Williamson, Proc. U. S. Nat. Mus., vol. XV, 1892, p. 211.

Neverita recluziana Desh., Gabb, Pal. Cal., vol. II, p. 77, 1869. Dall, Trans. Wagner Inst. Sci., vol. III, part 2, 1892, p. 396.

Polynices (*Neverita*) *recluziana* Petit, Arnold, Mem. Cal. Acad. Sci., vol. III, 1903, pp. 314, 315, pl. X, fig. 12.

"Shell ovate to flattened globular; spire only slightly elevated, obtuse; whorls three, slightly convex, body whorl having a long, slightly convex slope from suture to near base, where it suddenly turns under the umbilicus; surface ornamented with fine, oblique incremental lines: suture distinct, but not impressed; aperture semilunar; lip thin; columella incrusted, the incrustation extending down, completely covering the umbilicus."[47]

Dimensions: Length, 45; lat., 48.

Many of the young of this species are quite flat, the spire but little elevated, if elevated at all. Var. *Alta* Dall is also found in the same formation with the *P.* (*Neverita*) *recluziana.* The species is very variable in both size and shape.

This species is found in both the upper and lower series of the Clallam formation at Gettysburg, Wash.

Living: Lower California to Monterey, Cal. (Cooper).

Pleistocene: Santa Barbara, San Diego, San Pedro, Cal. (Arnold); San Diego to Santa Barbara (Cooper).

Pliocene: San Fernando, Santa Barbara (Cooper); San Diego, San Pedro (Arnold); San Diego well (Dall).

Miocene: Walnut Creek, Martinez, Santa Monica, Santa Inez, Cal. (Cooper).

Oligocene-Miocene: Gettysburg, Clallam county, Washington (Reagan).

28½. *Polynices* (*Neverita*) *saxea* Con.

Natica saxea Con., Wilkes's Expl. Exped., vol. X, p. 727, pl. 19, fig. 7.

Neverita saxea Con., Jour. Conch., 1865, p. 51.

Shell small, subglobose; spire slightly elevated, but proportionately elevated more than the spire of *N. reclusiana;* spire obtuse

47. Arnold, loc. cit.

to subacute; whorls five, convex; surface (a small patch of the shell covering still remaining on one of the casts) ornamented with wavy, oblique, incremental lines, some more prominent than their fellows; suture distinct; aperture semilunar to suboval.

This is a very common shell, running through all the series, both at Gettysburg and East Clallam.

Miocene: Oregon (Conrad).

Oligocene-Miocene: Gettysburg, East Clallam, Wash. (Reagan).

Subgenus *Lunatia* Gray.

Naticidæ with open umbilicus, without funiculum. Type. *Natica ampullaria* Lam.

29. *Polynices* (*Lunatia?*) *olympidii* n. s. Plate III, fig. 29.

Shell of medium size, ovate-globular; spire elevated, conic: whorls four, evenly convex, not shouldered; surface ornamented by fine, oblique incremental lines and by very faint revolving striæ on lower part of body whorl; suture distinct; aperture semilunar: outer lip sharp; inner lip incrusted; umbilicus open.

Dimensions: Axial length 26; lat. 20; aperture 15 x 10.

Distinguishable from *N. clausa* and *P. recluziana* in having a more elevated spire and in having its umbilicus open; and from *P. lewisii* in its smaller size, more elevated spire, its lacking the spiral groove, and by its having spiral striæ on the body whorl.

This species is found principally in the upper and lower series of the Clallam formation at Gettysburg, Wash. A few specimens resembling the type were seen at East Clallam.

Genus *Sigaretus* Lam.

Shell depressed, auriform, with minute spire and with aperture greatly distended; spirally striated or furrowed; whorls rapidly widening; color usually white, sometimes with a thin, corneous epidermis; operculum small, horny. *Sigaretus neritoideus* Linne is a characteristic species.

30. *Sigaretus scopulosus* Conrad. Plate III, fig. 30.

Sigaretus scopulosus Con., Wilkes's Expl. Exped., vol. X, p. 727, pl. 18, figs. 6, 6*a*, *b*, *c*.

Shell resembles *N. duplicata* Say very much, but is compressed and has the body whorl flattened a little on the upper part and also somewhat extended.

Shell flattened-globular, spire very slightly elevated, obtuse: whorls two and a half to three; whorls having a long, slightly convex slope from suture to near base, where it becomes a little rounded:

surface marked with numerous very fine, revolving lines; suture distinct; aperture semilunar; lip thin.

Dimensions: Longest diameter, 28; transverse diameter, 20; alt., 15; aperture in longest diameter, 22; transverse diameter, 19.5.

A single specimen of this species was obtained from the middle series at East Clallam.

Miocene: Astoria, Ore. (Conrad).

Oligocene-Miocene: East Clallam, Wash. (Arnold; Reagan).

Superfamily DOCOGLOSSA; Family LXXXIV TROCHIDÆ.
Genus *Trochita Schumacher.*

31. *Thochita inornata* Gabb. Plate III, fig. 31.

Trochita inornata Gabb (See Gabb, Pal. Cal., vol. II, 1869).

Shell irregularly depressed, low, conical, almost circular in outline; height two-thirds of width; volutions about two and one-half; suture indistinct to obsolete; surface of specimen entirely without ornamentation.

Dimensions: Diameter, 25; alt., 9.

The specimen obtained is from the lower series, East Clallam.

Miocene of California (Gabb).

Oligocene-Miocene: East Clallam, Wash. (Reagan).

Superfamily TÆNIOGLOSSA; Family DOLIIDÆ; Genus *Dolium* Lam.

Shell spirally ribbed; outer lip notched internally; canal short, obliquely directed.

32. *Dolium petrosum* Con. plate III, fig. 32; times, one-half.

Dolium petrosum Con., Wilkes's Expl. Expedition, vol. X, p. 722, pl. 19, figs. 3, 5.

Semiosis petrosus Con., Sm. Check List No. 474.

Dolipopsis petrosus Con., Jour. Conch., 1865, p. 150.

Shell large, subglobose to ovate globose in general outline; about a third higher than broad; whorls four or five in number; body whorl large and broadened at base by a broad reflected lip; spire moderately elevated; volutions distinct, carinated; surface marked by raised, rounded, revolving ribs, about twenty-one on the body whorl, with wide intervening grooves; the tenth and sixteenth spiral elevations are nodose, the nodes on the former being faintly shown, on the latter very pronounced, and the interspaces between the nodes continue as slightly depressed areas from base to apex of shell; shoulder angular, tuberculate, having a slightly concave space below the angle; also a revolving prominent line; aperture large; outer lip reflected.

By comparing the shell here described with the one in the geo-

logical collection of the Leland Stanford Junior University its spire was found to be less high.

Dimensions: Alt., 68; lat., 49; aperture, 44 x 30.

This species was found only in the clay shales near Gettysburg, Wash., by the writer. Mr. Arnold, however, found it represented in the sandstone that overlies these shales.

Miocene: Oregon (Conrad).

Oligocene-Miocene: Gettysburg, Wash. (Arnold; Reagan).

33. *Dolium biliratam* Con. Plate III, fig 33.

Dolium petrosum Con. (pars.), Wilkes's Expl. Exped., vol. X, p. 727, pl. 19, fig. 4.

Doliopsis biliratus Con., Jour. Conch., 1865, p. 150.

Semicosis? biliratus Con., Sm. Check List, 1866, No. 472.

The specimen obtained is much crushed longitudinally. It is a small shell and resembles the immature specimens of *Dolium petrosum* Con., but unlike them it has two revolving rows of large nodes on the body whorl; the ribs are also more elevated and more angular.

Dimensions: Alt., 19; diam., 14.

This specimen was obtained from the Oligocene-Miocene shales near Gettysburg, Wash.

Miocene: Astoria, Ore. (Conrad).

Oligocene-Miocene: Gettysburg, Wash. (Reagan).

SEA PLANTS.

?Macrocystis cf. pyrifera?.

The impressions of the stems of seaweed, doubtfully referred to the above genus, are often met with in the rocks of the Clallam formation, especially in the shale-bearing regions. They resemble the long, pipe-like tubes of the kelp so abundant in the strait adjacent at the present time.

A Compiled List of Fossils from the Clallam Formation (Oligocene-Miocene) Exposed Along the Strait of Juan de Fuca.

FOSSILS FROM THE GETTYSBURG SERIES.

Solemya ventricosa Conrad. (SL)
Solemya rubroradiata Conrad.
Leda sp.
Nucula (Acila) castrensis Hinds.
Nucula (Acila) gettysburgensis n. s.
Nucula sp.
Yoldia impressa Conrad. (SL)
Cytherea cf. vespertina Conrad. (SL)
Pecten clallamensis Arnold.

Pecten waylandi. Arnold.
Thracia cf. trapezoides Conrad. (SL?)
Thracia trapezoides Conrad.
Phacoides acutilineatus Conrad. (SL, SM)
Venus (Chione) vespertina Conrad.
Venus (Chione) angustifrons Conrad. (SL, M)
Venus (Chione) mathewsonii Gabb. (VM)
Venus (Chione) temblorensis Anderson.
Tellina sp.
Tellina (Angulus) sp.
Tellina albaria Conrad.
Mactra gibbsana Meek.
Dentalium substriatum Conrad.
Fusus sp.
Marginella or Erato sp.
Natica sp.
Polynices (Neverita) recluziana) Petit. (C)
Polynices (Neverita) saxea Conrad. (SL)
Polynices (Lunatia?) olympidii n. s.
Cyrodes aff. dowelli White.
Trochita inornata Gabb.
Olivella pedroana Conrad. (V, SP)
Perissolax sp.
Pleurotoma sp.
Scala sp.
Dolium petrosum Conrad. (M?)
Dolium bileratum Conrad.
Chrysodomus gettysburgensis n. s.
Cylichna petrosa Conrad.
Purpura canaliculata Ducal. (SP)
Aturia cf. ziczac Sowerby. (SL)
?Macrocystis cf. pyrifera?.

FOSSILS FROM THE EAST CLALLAM-NEAH BAY SERIES.

Leda sp.
Nucula sp.
Nucula (Acila) castrensis Hinds.
Nucula (Acila) gettysburgensis n. s.
Yoldia impressa Conrad. (SL)
Yoldia sp.
Arca sp.
Pectunculus patulus? Conrad.
Mytilus aff. mathewsonii Gabb.
Panopea generosa Gould. (SL?, V?)
Phacoides acutilineatus Conrad. (SL, V, SM)
Phacoides cf. nuttallii Conrad.
Cardium aff. quadrigenarium Conrad.
Venericardia sp.
Thyasira bisecta Conrad.
Venus (Chione) angustifrons Conrad. (SL, M)
Venus (Chione) aff. temblorensis Anderson.

Venus (Chione) olympidea n. s.
Venus (Chione) clallamensis n. s.
Cytherea cf. vespertina Conrad.
Saxidomus gibbosus Gabb. (V)
Pecten fucanus Dall?.
Pecten fucanus Dall.
Pecten propatulus Conrad.
Pecten (Chlamys) wattsi, var. morani Arnold?.
Tellina sp.
Tellina arctata Conrad. (SL?)
Tellina arctata, var. Juana n. var.
Tellina aff. bodegensis Hinds. (V?)
Tellina clallamensis n. s.
Metis alta Conrad.
Mactra gibbsana Meek.
Mactra sp. (C. and N. B.)
Teredo sp.
Teredo bulbosus n. s.
Dentalium sp.
Dentalium substriatum Conrad.
Crepidula praerupta Conrad. (SL?)
Fusus oregonensis Conrad. (SL)
Fusus sp. (C. and N. B.)
Scala (Opalia) sp.
Natica sp.
Polynices (Neverita) saxea Conrad. (SL)
Polynices (Lunatia?) olympidii n. s.
Sigaretus scopulosus Conrad. (SL, V)
Trochita inornata Gabb.
Pisiana clallamensis n. s.
Cancillaria sp.
Cylichna sp.
?Macrocystis cf. pyrifera ?

The species marked in the two lists above are also found in the Tertiary formations of California, as follows: (SL), San Lorenzo formation (Oligocene); (V), Vaqueros sandstone (Lower Miocene); (M), Monterey shale (Middle Miocene); (C), Carrizo Creek beds (Miocene); (SP), San Pablo formation (Upper Miocene); (SM), Santa Margarita formation (Upper Miocene).[48]

Lists of Fossils from Other Localities on the Pacific Coast Added for Correlation.

Species followed by (S) are found among the Gettysburg fossils; those by (SC) are represented in the East Clallam-Neah Bay series; those marked (S, SC) are represented in both series.

48. See Arnold's list of California fossils in Professional Paper No. 47, pp. 17-24.

FOSSILS FROM VANCOUVER ISLAND.

List from Carmanah Point (Miocene).[49]

Nucula divaricata Con. (S, SC)
Lucina acutilineata Con. (S, SC)
Mya abrupta Con.
Tellina oregonensis Con.
Crpeidula rostralis Con. (SC)
Dentalium substriatum Con. (S, SC)
Cerithiopsis oregonensis Con.
Priscofusus oregonensis Con.
Cardita ventricosa Gld.
Tellina albaria Con. (S)
Pectunculus patulus Con. (SC?)
Lunatia oregonensis Con. (S, SC)
Sinum scopulosum cf. Con. (SC)
Cylichna oregona Con. (S)
Loripes parilis Con.
Cytherea aff. vespertina Con. (S, SC)
Trochita aff. inornata Gabb. (SC)
Mytilus edulis Linn. (aff.)
Turritella, nov. sp.
Cardium, nov. sp.
Cytherea sp.
Solen sp.
Axinus bisectus Con. (SC)
Chrysodomus sp.
Venus pertonuis Gabb.
Veneroid (possibly Clementia).
Macoma nasuta Con.
Pachypoma biangulata Gabb (conf).
Mytilus cf. edulis Linn.
Pleurotoma indent.
Teredo sp.

List from the Sooke District[50] *(Middle Miocene).*

Placunanomia macroschisma Desh.
Mytilus edulis Linn.
Cerithidæ californica Hald.
Acmæa mitra Esch.
Crepidula rugosa Nutt (aff.).
Pecten æquisulcatus Carp. (conf.).
Pecten hostatus Sowb. (conf.).
Chrysodomus dirus Reeve.
Yoldia impressa Con. (S, SC)
Pectunculus patulus Con. (SC?)
Trochita inornata Gabb. (SC)
Sinum scopulosum Con. (conf.). (SC)
Fusus nov. sp. (a).
Fusus nov. sp. (b).

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49. Merriam, Univ. Cal. Geol., vol. 2, No. 3, pp. 103-104.
50. Merriam, loc. cit., p. 106.

Patelloid nov.
Massa (?) nov. sp.
Ancillaria nov. sp.
Cytherea nov. sp. (a).
Cytherea nov. sp. (b).
Bittium nov. sp. (?).
Crepidula sp.
Ostrea sp.
Cardium sp.
Tapes (?) sp.
Cerithidea sp.

FOSSILS FROM THE PUGET GROUP (LARAMIE?) OF KING AND PIERCE COUNTIES, WASHINGTON.[51]

Cardium (Adacna?) ?
Cyrene brevidens White.
Corbicula willisi White.
Corbicula pugetensis White.
Batissa newberryi White.
Batissa dubia White.
Psammobia obscura White.
Sanguinolaria? caudata White.
Teredo pugetensis White.
Neritina —?.
Cerithium —?.
Undetermined gasteropod.

FOSSILS FROM THE OREGON (ASTORIA) MIOCENE OF CONRAD.

Crustacea.

Calianassa oregonensis Dana.

Mollusca.

Mya abrupta (Panopea estrellana) Con.‡ (182).
*Solen curtis (Ensis curtus) Con.[52]
Thracia trapezoides Con. (S)
Solemya ventricosa Con. (S)
Donax? protexta (Hypogella protexta) Con.† (89).
Venus bisecta Con. (Thyasira bisecta) Con.‡ (135), also Wilkes's Exped. (SC)
Venus (Chione) angustifrons Con. (S, SC)
Venus lamellifera Con.
*Cytherea vespertina (Venus (Chione) vespertina) Con.† (118) (S, SC?)
Venus brevilineata (Venus (Chione) succinta Val.) Con.‡ (149).
Cytherea oregonensis (Venus (Chione) oregona) Con.† (95); also,.
Lucina acutilineata (Phacoides acutilineatus) Con.‡ (132) (S, SC)
Tellina arctata Con. (SC)
Tellina emacerata (Tellina bodegensis Hds.) Con.† (92).
Tellina albaria Con. (S)

51. White, Bull. U. S. Geol. Surv., No. 51, p. 58.

52. The species preceded by * are to be found described by Conrad in the *American Journal of Science*, vol. LV, 1848, pp. 432, 433, figs. 1-14. The species not preceded by the * are described by Conrad in Wilkes's Exploring Expedition, vol. X, pp. 722-730, pls. 17-20. The revised names followed by † are found in Gabb, Pal. Cal., vol. II, 1869, page indicated in the parentheses. And those followed by ‡ are found in Arnold, Mem. Cal. Acad. Sci., vol. III, 1903, page likewise indicated in the parentheses.

*Tellina oregonensis Con.
*Tellina obrupta Con.
Tellina nasuta (Macoma nasuta) Con.† (93).
Tellina bitruncata Con.
*Nucula abrupta (Neilo abrupta) Con.† (122).
Nucula divaricata (Nucula castrensis Hds.) Con.† (102) (S, SC)
*Nucula cuneiformis Con.
Nucula impressa (Yoldia impressa) Con.† pars. (102) (S, SC)
*Nucula penita Con.
Pectunculus patulus (Glycymeris patula) Con. (SC?)
Pectunculus nitens Con.
Arca devincta Con.
Arca.
Cardita subtenta (Venericardia ventricosa Gld.) Con.† (128).
Pecten propatulus Con. (SC)
Terebratula nitens Con.
Dolium petrosum Con. (S)
Dolium biliratum Con. (S)
Sigaretus scopulosus Con. (SC)
Natica saxea (Neverita saxea; Lunatia oregonensis) Con.† (see Gabb.) (S, SC)
Bulla petrosa (Cyclichna oregona and petrosa) Con. (S)
*Pyrula modesta (Ficopsis modesta) Con.† (113).
Crepidula prærupta Con. (SC)
Crepidula?.
Rostellaria indurata Con.
Cerithium mediale (Priscofusus medialis) Con.† (112).
Buccinum? devinctum (Priscofusus devinstus) Con.† (112).
Fusus geniculus (Priscofusus geniculus) Con.† (71).
*Fusus oregonensis (Tritonium oregonensis) Redfield† (73).
Fusus corpulentus (Priscofusus corpulentus) Con.† (112).
Natilus angustatus (Aturia ziczac Sby.) Con.† (69). (S)
Teredo substriatum (Dentalium substriatum) Con.† (115). (S, SC)
Turritella sp.
Territella sp. (No. 2).
Foraminifera.

Radiata.

Galerites oregonensis Dana.

Plants.

Abies robusta Dana.

From the above lists it is found that the fossils of the Clallam formation are only slightly related to the Miocene of California, but more related to the Oligocene of that state, there being eight species of the Gettysburg fossils represented in it and nine of the East Clallam-Neah Bay fossils, four of which are found both at East Clallam and at Gettysburg; or, to consider the formation as a whole, thirteen fossils are found to be common in the two formations, though some are doubtfully so considered. But not an Eocene fossil of California is represented in the Clallam formation, as is

also the case with the fossils of the Puget group of Washington. To review the Astoria (Oregon) Miocene list of Conrad, fourteen fossils of the Gettysburg series are represented in it and thirteen fossils of the Clallam-Neah Bay series, seven of which are also found at Gettysburg, making for the Clallam formation, as a whole, twenty species identical with those of the Astoria formation. To carry the correlation to the Tertiary fossils of Vancouver Island, it is found that of the fossils of the Sooke District only four are represented in the fossils of the Clallam formation, but the fossils of Carmanah Point have a better ratio. Ten are found to be identical. Also the Clallam-Neah Bay fossils are found to be more nearly related to the Carmanah Point fossils than those at Gettysburg, the ratio being ten to six; but the fossils of the whole formation are more related to the Astoria Miocene. It therefore seems that the age of the Clallam formation is practically the same as that of the Astoria formation.

GENERAL REMARKS.

Pliocene.—In Pliocene times the lower courses of practically all the streams flowing into the Pacific, and also of the Hoko and Clallam rivers, flowing into the strait, were submerged. In addition, the great synclinal trough reaching from the mouth of the Suez river and Waatch strait eastward far into the Bogachiel country, and practically from the coast northward nearly to the westward extension of the Olympic axis, was covered with a deep sea, so that whales made it their playground. Then at the close of the epoch most of the region was elevated above the sea, all on the Pacific side to be submerged again in the Pleistocene. The distinct formations represented in the region are as follows:

Hoko Formation.—A series of conglomerates occupy the territory from the Hoko river in its lower course eastward to Clallam Bay, and is seen to rest unconformably upon the upturned and eroded sandstones and shales of the Clallam formation. The boulders of this formation were seen to contain Miocene fossils. The formation certainly being pre-Pleistocene, the above evidence locates it with certainty in the Pliocene (Arnold). Its thickness is approximately 300 feet.

Raft River Formation.—An outcrop on the north side of the mouth of Raft river contains concretionary sandstone and gray shale, which Doctor Arnold considers an equivalent of a portion of the Quinaielt formation, described next below.

Quinaielt Formation.—Doctor Arnold's description (in part):[53]

53. Geological Reconnaissance of the Olympic Peninsula, Washington, Bull. Geol. Soc. Am., vol. 17, p. 465.

This formation occupies "a great syncline between capes Elizabeth and Granville, through the trough of which the Quinaielt river empties into the sea. The formation in which this syncline is developed is therefore termed the Quinaielt. The Quinaielt consists of over 2200 feet of conglomerates and shales, with minor quantities of sandstone. The conglomerates are developed on the north of the river, while the shale, with some underlying sandstone, occurs south of it. Owing to the fact that faults limit the syncline on both sides, it is impossible to determine positively which facies of the formation, the conglomerate or the shale, was the older. However, it appears most likely that the latter represents the basal portion of the formation. The beds contain well-preserved marine fossils, and the conglomerates in particular considerable quantities of almost unaltered wood and bark of trees, often in large fragments." The fossils from this formation, listed below, make it contemporaneous in age with the Purisima formation of central California.

Quillayute Formation.—This formation occupies the valley of the Quillayute river and the country drained by its eastern tributaries eastward at least to their respective middle courses, thence westward to Waatch strait, the formation extending outward to the coast now and then. The boundaries of the formation were not ascertained. In the interior region, where exposed along the Bogachiel river, it is composed of sandstone and bluish-gray shale; the coast exposures are all conglomerates or a coarse gravelly rock resting unconformably upon the older rocks exposed there. The base of the formation was not seen in the interior region. The thickness of the formation, consequently, was not ascertained The sandstone series was found to be extremely fossiliferous, and in it the fossils are beautifully preserved. Fossils were found at two horizons—in the north bank of the Bogachiel river in a bluish-gray rock in section 22, township 28 north, range 14 west of the Willamette meridian, and in the bluff south of the abandoned channel of Maxfield creek on the south side of the Bogachiel river, in sections 28 and 29 of the township and range above. But fossils were obtained only from the latter location, as the former was below the surface of the water of the river at the time visited. Below is a description of the fossils obtained.

Fossils of the Quillayute Formation (Lower? Pliocene) Exposed in the Vicinity of Quillayute, Wash.

The only Pliocene fossils so far mentioned in the state, so far as the writer can learn, are those of the Quinaielt formation, some

sixty miles south of Quillayute, down the coast. The age of the formation is the same as that of the Purisima formation (Lower Pliocene) of Central California (Arnold). For comparison, Doctor Arnold's list of fossils from this formation is given side by side with the list of fossils obtained at Quillayute by the writer, as both lists are from the Olympic Peninsula.

PLIOCENE FOSSILS FROM THE OLYMPIC PENINSULA, WASHINGTON.

Fossils from the Quillayute formation.	*Doctor Arnold's list from the Quinaielt formation.*
Scutella sp.	
(M, P)*Nucula castrensis Hinds.	
	Leda sp. (short and smooth).
Yoldia cooperi Gabb.	Yoldia cf. cooperi Gabb.
	Lima cf. hamlini Dall.
(M?, P?)*?Phacoides acutilineatus?.	
(P?) Phacoides nuttallii?.	
(M, P) Cardium meekianum Gabb. (*)	
(M) Cardium (Ceratoderma) corbis Martyn.	
Tivila crassatelloides Conrad.	
*Venus (Chione) matthewsonii Gabb. (*)	
(M, P) Tapes staleyi Gabb. (*)	Tapes cf. staleyi Gabb.
(M, P) Macoma inquinata Deshayes.	Macomo sp.
Tagelus californicus Conrad.	
(M, P) Solen sicarius Gould.	Solen sicarius Gould.
(M, P) Mactra californica Conrad.	Mactra sp.
Mactra exoleta Gray.	
(P) Mactra hemphilli Dall. (*)	
(P) Mactra (Spisula) catilliformis?.	
(M, P) Mactra (Spisula) falcata Gould.	
Mya truncata Linn. (*)	
(M, P)*Panopea generosa Gould.	
	Pecten hastatus var. hericius Gould.
	Thracia trapezoides Conrad.
	Anachis sp.
Cylichna alba Brown.	Cylichna sp.
	Margarita sp.
(M, P) Pleurotoma perversa Gabb.	Pleurotoma perversa Gabb.
(M) Bela fidicula Gould. (*?).	
Bela sanctæ monicæ Arnold? (*)	
(M)*Olivella pedroana Conrad.	
Buccinum bogachielii n. s.	
Chrysodomus giganteus n. s. (*)	Chrysodomus aff. tabulatus Baird.
Chrysodomus stantoni Arnold.	
Neptunea maxfieldii n. s. (*)	
(M) Monoceros engonatum Conrad.	
Trophon sp.	
	Opalia cf. borealis Gould.
	Priene aff. oregonensis Redfield.
(P) Purpura crispata Chemnitz.	Purpura crispata Chemnitz.
Purpura lapillus Lam.	
Purpura lapillus var. quillayutea n. var.	
(M)*Purpura canaliculata Duclos.	Purpura canaliculata Duclos.
	Purpura saxicola Valenciennes.
	Solariella peramabilis Carpenter.
Eulima washingtoni n. s. (*)	
Ranella marshallii n. s. (*)	
Aporrhais (Arrhoges) quillayutensis n. s. (*)	
(M, P) Natica (Cryptonatica) clausa Broderip & Sowerby.	Natica clausa Broderip & Sowerby.
(M, P) Polynices (Lunatia) lewisii Gould.	
Whale-ribs.	

By comparing the above lists it is found that only five species are common to both formations. It is also found by comparing the Quillayute list with lists of living species that about two-thirds of the species given in it are living at the present time, six of which are now living in Quillayute Bay adjacent.[54] The fossils that are supposed to be extinct are followed by a *.

The species in the Quillayute list above that are preceded by a * have been described in the Oligocene-Miocene fossils, to which the reader is referred for a description of each. The other Quillayute fossils are described below.

The species preceded by (P) are also found in Purisima-San Diego (Lower Pliocene) formation of California, and those marked (M) are found in the Merced-Deadman Island (Upper Pliocene) of the same state. It is thus seen that sixteen fossils from the Purisima-San Diego formation, two doubtfully so classed, and seventeen from the Merced-Deadman Island formation are found in the Quillayute formation.[55] Also, by comparing Doctor Arnold's Pleistocene lists with the lists from this formation, it is found that twenty of the fossils are common.[56] The percentage, therefore, seems to favor an Upper Pliocene for the age of the Quillayute formation. And again, a like percentage of the fossils are represented in the Miocene. Consequently, this would seem to place the formation at the base of the Pliocene. Following is a description of the fossils:

ECHINODERMATA.

Class II ECHINOIDEA; Sub-branch III EUECHINOIDEA.
Order IV CLYPEASTROIDA; Family 3 SCUTELLIDÆ; Genus *Scutella* Lam.

Scutella sp.

The inside cast of a specimen of this genus was found in the Quillayute formation at the abandoned mouth of Maxfield creek, near Quillayute, Wash.

MOLLUSCA.

Class PELECYPODA; Order PRIONODESMACEA.
Superfamily NUCULACEA; Family VI LEDIDÆ; Genus *Yoldia* Möller.

Shell oblong, slightly attenuated behind; compressed, gaping, smooth or obliquely sculptured with a dark-olive, shining epidermis; external ligament slight; hinge as in *Nucula* and *Leda;* pallial sinus deep. (After Arnold.)

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54. See Reagan, "Some Sea Shells from La Push, Wash." Trans. Kan. Acad. Sci., vol. XXI, part I, 1907, pp. 168-177.

55. See Professional Paper No. 47, pp. 28-32.

56. Loc. cit., pp. 33-37.

34. *Yoldia cooperi* Gabb. Plate IV, fig. 34.

Yoldia cooperi Gabb, Proc. Cal. Acad. Sci., vol. III, 1865, p. 189; Pal. Cal., vol. II, 1869, p. 31, pl. IX, fig. 54; Williamson, Proc. U. S. Nat. Mus., vol. XV, 1892, p. 192; Dall, Trans. Wagner Inst. Sci., vol. III, 1898, p. 594; Arnold, Mem. Cal. Acad. Sci., vol. III, pp. 99, 100. In part, Cooper, 7th Ann. Rept. Cal. St. Min., 1888, p. 270; also, in part, Gabb (*fide* Pal. Cal., vol. II, 1869, p. 59).

Shell thin, oblong, very inequilateral, subcompressed; anterior end subaccuminate, pointed, concave above; posterior end broadly rounded; posterior ventral margin meeting the posterior extremity in a broad, rounded curve, from which it continues broadly arcuate to about opposite the beak, when it curves rapidly upward to the anterior end; beaks minute and placed in advance of the middle; surface sculptured by numerous small concentric ribs, which are less abrupt on the upper side and slope downward on the side towards the base; hinge with numerous sharp teeth; inside of shell not seen.

Dimensions of medium-sized mature specimen: Lat., 58; alt., 29; umbo to anterior extremity, 17; to posterior extremity, 37.

Dimensions of largest specimen figured: Lat., 58; greatest alt., 32; from umbo to posterior extremity, 40; to anterior extremity, 22.

This species is quite variable, depending upon the age. It differs from *Y. impressa* Con. (Wilkes's Exped.) in its much greater length and altitude and in its being more compressed.

Living: Half Moon Bay, California (Arnold); San Diego to Santa Sruz (Cooper).

Pleistocene: Ventura, San Diego, Cal. (Arnold); San Pedro (Arnold; Cooper).

Pliocene: San Fernando (Cooper); Portata Valley. California (Arnold).

? Pliocene: Mouth of Quinaielt river, Granville, Wash. (Arnold): Quillayute, Wash. (Reagan).

Order TELEODESMACEA; Superfamily CARDIACEA.
Family XXVI CARDIIDÆ; Genus *Cardium* (Linné) Lamarck.

Shell cordate, inflated, variously sculptured, usually striated or radially ribbed, usually closed but sometimes slightly gaping; beaks prominent; lunule or escutcheon absent; pallial line distant from margin of the valves.

35. *Cardium meekianum* Gabb. Plate IV, fig. 35; times, one-half.

Cardium meekianum Gabb, Pal. Cal., vol. II, p. 27, pl. 7, fig. 46, 1869.

Gabb's description (in part): "Shell large; beaks large, strongly incurved and pointed forwards; shell broadly rounded anteriorly and very oblique and abruptly truncated posteriorly; surface

marked by twenty-two radiating ribs, which are acute in young shells, becoming rounded as they increase in size, and ultimately becoming distinctly flattened on top; these are crossed by irregular, curved, subsquamose plates, which, toward the beaks, lose their lamular character and are represented by little tubercles; posterior face of shell costate, but the ribs are less prominent; the interior spaces between the ribs are narrow and usually flat, though some are concave."

Dimensions of largest specimens obtained: Alt., 73; lat., 67; diam. of right valve, 19.

This is quite a numerous species in the Pliocene at Quillayute, Wash.

Pliocene: Humboldt county, California (Gabb); Quillayute, Wash. (Reagan).

Subgenus *Cerastoderma* Mörch.

Shell rotund or obovate, with strong ribs obsoletely granulore or intricate or smooth; no posterior or anterior area; channels single; hinge normal (Arnold).

36. Cardium (*Cerastoderma*) *corbis* Martyn. Plate IV, fig. 36.

Cardium corbis Mart., *Pectunculus corbis* Mart., Univ. Conch., pl. XXVIII, fig. 2, p. 1784. Carpenter, Brit. Assn. Rept., 1863, p. 642; equals *C. californicum* Con. and *C. nuttallii* Con. (see Gabb, Pal. Cal., vol. II, p. 98, 1869). Cooper, 7th Ann. Rept. Cal. St. Min., 1888, p. 232. Keep, West Coast Shells, p. 180, fig. 53, 1892. Dall, Trans. Wagner Inst. Sci., vol. III, part 5, 1900, p. 1093. Arnold, Mem. Cal. Acad. Sci., vol. III, p. 140, 1903.

Shell very variable, large, subtrigonal, ventricose; umbones prominent, anterior; surface ornamented with about thirty to thirty-seven regular, slightly squarish, close set, radiating ribs, which are occasionally rugose, the ridges being less rounded near the posterior margin; inter-rib spaces channel-like grooves; margin crenulated; interior not seen.

Dimensions: Alt., 38.5; lat., 35; diam., 24.

Three specimens of this species were found on the north bank of the Bogachiel river in the Pliocene formation near Mr. Earl Wilson's homestead, some five miles southeast of Quillayute post-office.

Living: Kamchatka, Santa Barbara to Kodiac (Cooper).

Pleistocene: San Francisco, San Pedro, Monterey (Cooper); Santa Barbara, San Pedro (Arnold).

Pliocene: North bank of Bogachiel river, near Mr. Earl Wilson's homestead, Quillayute, Wash. (Reagan).

Superfamily VENERACEA; Family XXVII VENERIDÆ.
Subfamily VENERINÆ; Genus *Tivela* Link.

"Shell triangular, subequilateral, cuneiform; three to five cardinal teeth in one valve, four to six in the other; anterior lateral tooth narrow, elongated, compressed; pallial impression with a short oblique or sometimes horizontal sinus."[57]

37. *Tivela craisatelloides* Conrad. Plate IV, fig. 37; times, one-half.

Cytherea (*Trigonella*) *crassatelloides* Con., Jour. Phil. Acad. Sci., vol. VII, 1837, p. 253, pl. XIX, fig. 17. Hinds, Voyage Sulphur, p. 65, pl. XXI, fig. 1, 1844; equals *Donax stultorum* Marve, Linne, Lyst. Conch., pp. 37, 40, pl. IX, fig. 7, 1823; equals *D. stultorum* Mar., Gray, Index, Test. Suppl., pl. II (Donax), fig. 2, 1828.

Cytherea crassatelloides Con., Hanley, Descr. Cat. Rec. Bivalve Shells, p. 106, 1843. Sowerby, Thes. Conch., vol. II, p. 612, pl. CXXVII, figs. 1–3. Reeve, Conch. Icon., vol. XIV, pl. I, fig. 3, 1864; equals *Cytherea stultorum* Gray, Hanley, Descr. Cat. Rec. Bivalve Shells, p. 106, 1843; equals *Trigonella crassatelloides* Con., Jour. Phil. Acad. Sci., vol. I, 1849, p. 213; equals *Trigonia stultorum* Gray, Deshayes, Cat. Conch. Coll. B. M., part I, p 46, 1853; also *Trigonia crassatelloides* Con., Deshayes (loc. cit.); equals *Cytherea solodissima* Phil. Gabb, Pal. Cal., vol. II, p. 96.

Pachydesma crassatelloides Con., Proc. Phil. Acad. Sci., 1854, p. 121. Carpenter, Brit. Assn. Rept., 1863, p. 640. Cooper, 7th Ann. Rept. Cal. St. Min., 1888, p. 256. Keep, West Coast Shells, p. 189, fig. 62. *Tivela crassatelloides* Con., Williamson, Proc. U. S. Nat. Mus., vol. XV, 1892, p. 187; equals *Cytherea* (*Tivela*) *crassatelloides* Con., Stearns, Proc. U. S. Nat. Mus., vol. XXI, 1898, pp. 371–378, pls. XXIII–XXV; also Nautilus, vol. XIII, 1899, p. 73. Arnold, Mem. Cal. Acad. Sci., vol. III, p. 143, 1903.

Shell large, thick, almost equilateral-triangular in shape, ventricose; umbones subcentral to slightly anterior to center, not very prominent; anterior dorsal margin straight to near middle transverse line of shell, rather equally rounded at base; posterior margin sharp, nearly straight; posterior extremity more obtusely rounded than anterior (in some cases it is almost angular); ventral margin elliptically to prominently and evenly arcuate; surface sculptured with very fine to very coarse incremental lines according to age of specimen; a posterior submarginal angular ridge is shown on some specimens, but is nearly or entirely obsolete in old specimens; cartilage-pit triangular, not wide, rather deep, separated from posterior ligamental groove by a prominent thick ridge; cardinal ridges (teeth) three in number, prominent, thick, anterior lateral tooth elongated.

Dimensions of medium-sized mature specimen: Lat., 96; alt, 80; diam., 37; umbones to anterior extremity, 69; to posterior extremity, 72.

The specimens of this species obtained differ from the Mactras in being more equilateral-triangular in shape, by being less gib-

57. After Arnold (see below).

bous when mature, and by their having a thick shell and heavy cardinal teeth. They also differ from the living *T. crassatelloides* in having their beaks more central.

A very abundant species in the Quillayute Pliocene.

Living: San Diego to Santa Cruz, Cal. (Cooper).

Subfamily TAPETINÆ.

38. *Paphia* (*Tapes*) *staleyi* Gabb. Plate IV, figs. 38*a*, *b*, *c*.

Dosinia staleyi Gabb, Pal. Cal., vol. II, p. 24, pl. 7, fig. 42.
Tapes staleyi Gabb, Pal. Cal., vol. II, 1869, p. 57, pl. 16, figs. 17, 17*a*.

Shell large, subcircular, convex, thick, very inequilateral; beaks large, prominent, anterior, and turned forward; lunule faint, rather large, slightly sunken; hinge same as *Tapes staminea;* surface sculpture also same as *T. staminea*, except that the ribs and frills are at least four times as numerous as in that species; pallial sinus very deep and rather narrow.

This is a very abundant species in the Pliocene at Quillayute, Wash.

Very common in the Tertiary of California (Gabb).

Pliocene: Quillayute, Wash. (Reagan).

Superfamily TELLINACEA; Family XXX TELLINIDÆ.
Genus *Macoma Leach;* Sungenus *Macoma* s. s.

Shell subtrigonal, smooth, usually colorless; anal siphon long; brachial siphon very short; pallial sinus coalescent with the pallial line below; hinge without laterals; inhabiting the cooler seas, and especially boreal waters.

39. *Macoma inquinata* Deshayes. Plate IV, fig. 39.

Tellina inquinata Desh., Proc. Zool. Soc. 1854, p. 357.
Macoma inquinata Desh., Carpenter, Brit. Assn. Rept., 1863, p. 89. Gabb, Pal. Cal. vol. II, p. 93, 1869. Cooper, 7th Ann. Rept. Cal. St. Min., 1888, p. 248. Keep, West Coast Shells, p. 195, 1892. Dall, Trans. Wagner Inst. Sci., vol. III, part 5, 1900, p. 1053. Arnold, Mem. Cal. Acad. Sci., vol. III, p. 162, 163, pl. XVI, fig. 4, 1903.

Shell suboval, convex, equivalve; umbones subcentral; posterior end evenly arcuate from umbo and acutely rounded from about half way between dorsal and ventral margins to posterior extremity; anterior end rather prominently dilated, especially so in front of umbo of right valve; interior of shell not seen.

Demensions of right valve of the largest and most perfect specimen obtained: Lat., 42; alt.. 34; diam., 14; from umbo to posterior extremity, 29; to anterior extremity, 31.

This species is rare in the Quillayute formation, represented at the mouth of Maxfield creek, near Quillayute.

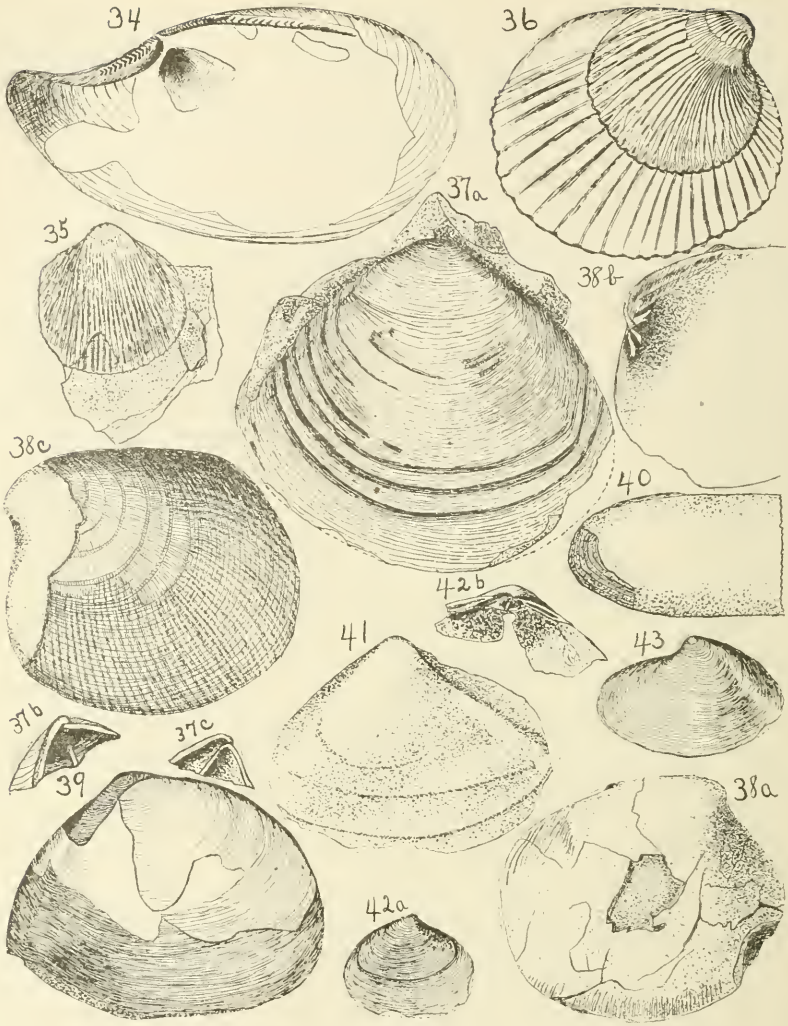

PLATE IV.

FIG. 34. Yoldia cooperi Gabb; a broken left valve, showing hinge of right valve.
FIG. 35. Cardium meekianum Gabb; cast of young specimen.
FIG. 36. Cardium (Cerastoderma) corbis Martyn.
FIG. 37*a*. Tivela crassatelloides Conrad; times, one-half.
FIG. 37*b*, 37*c*. Hinges of *T. crassatelloides?* specimens.
FIG. 38*a*. Paphia (Tapes) stalyi Gabb; a cast.
FIG. 38*b*. Hinge of 38*a*, above.
FIG. 38*c*. Drawing showing outside of valve of another specimen of the same species as 38*a*, above.
FIG. 39. Macoma inquinata Deshayes.
FIG. 40. Tegalus californicus Conrad; a much broken specimen.
FIG. 41. Mactra californica Conrad; a cast; times, one-half.
FIG. 42*a*. Mactra exoleta Gray.
FIG. 42*b*. Drawing of a broken valve of the same species, showing hinge. Both specimens are immature shells.
FIG. 43. Mactra hemphilli Dall; an immature shell.

Living: Alaska to San Diego (Cooper); Quillayute Bay, Washington (Reagan).

Pleistocene: San Pedro, Cal. (Arnold); San Diego to Monterey (Cooper).

Pliocene: San Fernando, Twelve Mile House, California (Cooper); Quillayute, Wash. (Reagan).

Family XXXII PSAMMOBIIDÆ; Genus *Tagelus* Gray.

40. *Tagelus californianus* Cont. Plate IV, fig. 40; times, one-half.

Only a fragment of a specimen of this species was obtained.

It was found among the *Mactra* shells of the Quillayute formation from the old mouth of Maxfield creek.

Superfamily MACTRACEA; family XXXV MACTRIDÆ.
Subfamily MACTRINÆ; Genus *Mactra* Linne.

"Shell nearly equilateral; anterior hinge tooth A-shaped, with sometimes a small laminar tooth close to it; lateral tooth doubled in right valve; ligament set off by a shelly lamina rising between chondrophore and ligament; cardinals generally coalescent above: laterals smooth or finely granular."[58]

Type, *Mactra stultorum* Linne.

41. *Mactra californica* Conrad. Plate IV, fig. 41; times, one-half.

Mactra californica Con., Jour. Phil. Acad. Sci., vol. VII, 1837, p. 240, pl. XVIII, fig. 12; Williamson, Proc. U. S. Nat. Mus., vol, XV, 1892, p. 187; Dall, Trans. Wagner Inst. Sci., vol. III, part 4, 1898, p. 876; Arnold, Mem. Cal. Acad. Sci., vol. III, pp. 174-176, pl. XIX, fig. 2, 1903.

Standella californica Con., Carpenter, Brit. Assn. Rept., 1863, p. 640; Cooper, 7th Ann. Rept. Cal. St. Min., 1888, p. 265.[59]

"Shell of medium size, subtrigonal, subequilateral, compressed, thick; umbones subcentral, turned anteriorly, margin only slightly arcuate; posterior side with a narrow, submarginal fold; posterior extremity quite sharply rounded; ventral margin evenly arcuate: surface sculptured with fine concentric lines;" interior of shell not seen.[59]

A single specimen of this species was obtained from the Quillayute formation, Middle Pliocene, at the old mouth of Maxfield creek, near Quillayute, Wash.

Living: San Diego to San Francisco (Carpenter).

Pleistocene: San Diego, San Pedro, Cal. (Arnold).

Pliocene: Quillayute, Wash. (Reagan).

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58. Arnold (in part).
59. Arnold (in part). See above.

42. *Mactra exoleta* Gray. Plate IV, figs. 42*a*, 42*b*.

Mactra exoleta Gray, equals *Lutraria ventricosa* Gld. (*fide* Carpenter, Proc. Zoöl. Soc., 1856, p. 200). Arnold, Mem. Cal. Acad. Sci., vol. III, p. 175, pl. XIX, fig. 4, 1903.

Arnold's description : "Shell of medium size, decidedly trigonal, ventricose, thin, fragile ; umbones slightly anterior to center, elevated, not touching, turned only slightly forward ; anterior dorsal margin straight ; anterior extremity evenly rounded near base ; ventral margin evenly arcuate ; posterior dorsal margin arcuate, making an acute angle with the ventral margin ; a sharp, prominent, angular ridge runs from umbo to the posterior extremity ; surface sculptured with fine, incremental lines, which are most prominent posterior to ridge ; cartilage-pit deep ; hinge teeth lamellar, long ; ligamental groove very deep, narrow."

This species is well represented in the Quillayute formation at the mouth of Maxfield creek, opposite Quillayute, Wash.

Living : Coast of Mexico.

Pleistocene : San Diego, San Pedro, Cal. (Arnold).

Pliocene : Quillayute, Wash. (Reagan).

43. *Mactra hemphilli* Dall. Plate IV, fig. 43.

Mactra hemphilli Dall, Nautilus, vol. VII, 1894, p. 137, pl. V; Arnold, Mem. Cal. Acad. Sci., vol. III, p. 175, pl. XIX, fig. 3, 1903.

The classification of this shell is based upon its having its anterior portion hollowed in front of umbo, making the dorsal margin slightly concave, as is a leading characteristic of the species; interior of valve not seen. Shells collected are all small and immature.

Shell subtrigonal, subequilateral, convex, thin; umbones subcentral, slightly elevated, turned slightly forward; anterior end evenly rounded; posterior dorsal margin evenly arcuate; posterior end most produced near base: surface sculptured with fine incremental lines.

This is an abundant species in the Quillayute formation at the old mouth of Maxfield creek.

Pleistocene: San Pedro, Cal. (Arnold).

Pliocene: Quillayute, Wash. (Reagan).

43½. *Mactra catiliformis?*.

Only a fragment of a shell was obtained, which is doubtfully classed as above. The posterior and anterior dorsal margins have the same declining angle from the beak as *M. catiliformis:* but the characteristic fold posteriorly is lacking.

Shell found among the other *Mactras* from the Quillayute formation.

44. *Mactra* (*Spisula*) *falcata* Gould. Plate V, fig. 44.

Mactra falcata Gld., Proc. Bost. Soc. Nat. Hist., vol. III, 1850, p. 216; Wilkes's Expl. Exped., vol XII, p. 393, fig. 506, 1852.

Standella falcata Gld., Carpenter, Brit. Assn. Rept. 1863, p. 640; Gabb, Pal. Cal. vol. II, p. 92, 1869.

Standella nasuta Gld., Cooper, 7th Ann. Rept. Cal. St. Min., 1888, p. 266; Keep, West Coast Shells, p. 88, 1892.

Mactra planulata var. *falcata* Gld., Williamson, Proc. U. S. Nat. Mus., vol. XV, 1892, p. 187.

Mactra (*Spisula*) *falcata* Gould., Arnold, Mem. Cal. Acad. Sci., vol. III, pp. 176, 177, pl. XIX, fig. 1.

Arnold's description:[60] "Shell of medium size, transversely ovate-triangular, convex, rather thin; umbones about central, elevated; anterior dorsal margin nearly straight; anterior extremity rounded near the base; ventral margin subarcuate; posterior dorsal margin slightly arcuate, and in left valve forming a slight angle behind the umbo; posterior extremity not quite so sharply rounded as anterior extremity; submarginal posterior ridge rounded, not prominent; hinge as in *M. catiliformis*, except cartilage-pit less prominent; pallial sinus rather long, with rounded extremity horizontal; two broad flat ridges radiate from umbo on interior surface, forming a long, triangular depression between them."

Dimensions: Some of the older specimens are more than 100 mm. in length and 80 mm. in altitude. A medium specimen measures: Length, 82; alt., 66; diam., 32. A smaller specimen measures: Length, 12; alt., 6; diam., 6.

"Distinguishable from other species by narrower, more acutely rounded anterior end and interior radiating ridges. Resembles *M. californica*, but is distinguishable by smaller pallial sinus, lack of ridge between cartilage-pit and anterior ligamental groove, and by the interior radiating ridges and narrow anterior end."

This species is abundant in the Pliocene of Quillayute, Wash. A single specimen was also obtained from the upper series of the Oligocene-Miocene at Gettysburg, Wash.

Living: San Diego, Cal., to Kodiak, Alaska (Cooper).

Pleistocene: San Deigo (Cooper; Arnold); San Pedro, Cal. (Arnold).

Pliocene: Kirker's Pass, Contra Costa county, Eagle Prairie, Humboldt county, California (Cooper); Pliocene, Quillayute, Wash. (Reagan).

Miocene: Martinez, Sunol, Alameda county; Santiago, Los Angeles county; Foxin's, Santa Barbara county; Half Moon Bay, San Mateo county; Griswold's, San Benito county; Siebeck's, Santa Clara county, California (Cooper).

Oligocene-Miocene: Gettysburg, Wash. (Reagan).

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60. Loc. cit.

45. *Mactra* (*Spisula*) *falcata?*. Plate V, figs. 45, *a*, *b*, *c*.

This species resembles *M. falcata*, except it is more oval in outline; inside of shell not seen. It also resembles *M. Gibbsana* but is less gibbous and has less prominent umbones.

Found with the other *Mactras* in the Quillayute formation at the old mouth of Maxfield creek.

Superfamily MYACEA; Family XXXVI MYACIDÆ; Genus *Mya*.

Shell solid, large, irregular, gaping behind; hinge edentulous; surface smooth.

46. *Mya truncata* Linne. Plate V, fig 46; times, one-half.

Mya truncata Linn. Crag. Moll., vol. II, p. 277, tab. XXVIII, fig. 1. Sears V. Wood, supplement to the Mont. Crag. Moll. Pal. Soc., vol. 27, p. 136. Billings, Geol. Can. 1863, p. 963, fig. 474. Arnold, U. S. G. S. Bull., 309, pl. 18, fig. 1.

Posterior extremity of shell (cast) broken. Shell large, rather thin; valves unequal, elongated, rounded in front and gaping behind, with a sinus trough-like area back of front margin, the one in the right valve being wider and deeper than the one in the left valve; umbones of medium size, placed anteriorly and pointed forward; surface smooth except for very fine incremental lines of growth.

Dimensions: Alt., 61.

A single specimen was obtained from the Quillayute formation.

Recent fauna: Arctic regions (Arnold).

Pleistocene, etc.: This species is found in England, in the Red Crag of Butley; in the Scrobicularia bed; in the Fluvio-Crag, at Bramerton; in the Chillesford bed, at Chillesford; at Sudborn Church Walks; in the glacially, pebbly sands at Kunten Gap, and in the middle glacial sands at Hopton, and at Bridlington (Wood).

Post-Tertiary of Canada (Logan; Billings).

Pliocene: California (Logan; Billings); Fernando formation of Elsmere Cañon, near Newhall. Los Angeles county, California (Arnold); Quillayute, Wash. (Reagan).

Class VII GASTEROPODA; Order OPISTHOBRANCHIATA.
Family XLIII SCAPHANDRIDÆ; Genus *Cylichna* Loven.

"Shell strong, cylindrical, smooth or punctate-striæ; spire minute or truncated; aperture narrow, rounded in front; columella callous, with one plait. *Cylichna arachis* Quoy. is a characteristic species." (Arnold.)

47. *Cylichna alba* Brown. Plate V, fig. 47.

Cylichna cylindracea (non-Linne), Cpr., Brit. Assn. Rept., 1863, p. 647; Cooper 7th Ann. Rept. Cal. St. Min., 1888, p. 238.

Volvaria alba Brown, Illustr. Conch. G. B., p. 3, pl. XIX, figs. 43, 44.
Cylichna alba (Brown) Loven, Ofversight K. Vet.-Akad, Forth., 1846, p. 242. Tryon, Man. Conch., vol. XV, p. 290, pl. LX, fig. 16, 1893.[61] Arnold, Mem. Cal. Acad. Sci., vol. III, p. 192, pl. X, fig. 18.

"Shell small, cylindrical, smooth; spire truncated; aperture narrow posteriorly for about two-thirds length of shell, when the inner lip gradually retracts to the columella, forming a rounded anterior end to aperture; columella callous, with one plait."[61]

Only a broken specimen of this species was obtained from the Pliocene of the Quillayute formation.

Living: San Diego to Monterey, Cal. (Cooper).

Pleistocene: San Diego, Ventura, San Pedro (Arnold): San Diego, Santa Barbara, Cal. (Cooper).

Pliocene: San Diego well (Cooper); Quillayute, Wash. (Reagan).

Superorder STREPTONEURA; Order CTENOBRANCHIATA.
Superfamily TOXOGLOSSA; Family LII PLEUROTOMIDÆ.
Genus *Pleurotoma* Lamarck.

"Shell turriculated, fusiform, terminated anteriorly by a straight, more or less long canal; aperture oval; columellar lip smooth, straight or sinuous; outer lip somewhat sinuous, with a posterior sinus. *Pleurotoma babylonia* Lam. is a characteristic species." (Arnold).

48. *Pleurotoma perversa.* Plate V, fig. 48.

Pleurotoma perversa Gabb., Proc. Cal. Acad. Sci., vol. III, 1865, p. 183; Pal. Cal., vol. II, pp. 6, 73, pl. I, fig. 10, 1869. Cooper, 7th Ann. Rept. Cal. St. Min., 1888, p. 260; equals *Surcula perversa* Gabb, Tryon, Man. Conch., vol. VI, p. 239, pl. VI, fig. 79, 1884. Arnold, Mem. Cal. Acad. Sci., vol. III, p. 200, 1903.

Shell small, sinstral, elongate, slender; whorls eight to twelve; spire high; spire in specimens at hand bent a little near apex; suture deep; body whorl, including canal, nearly half of the entire length of the shell; aperture, except lower end of canal, not seen; canal extended; surface smooth except for fine incremental, somewhat wavy lines, which are now mostly weathered away.

Dimensions: Axial length, 37; lat. of body whorl, 11; length of body whorl, 21.

Only a few specimens were obtained from the Quillayute formation.

Living: Catalina Island, Cal., to Vancouver Island (Cooper).

Pleistocene: San Pedro to Santa Barbara (Cooper); San Pedro (Arnold).

Pliocene: San Pedro, Cal.; mouth of Quinaielt river, near Grandville, Wash. (Arnold); Quillayute, Wash. (Reagan).

61. After Arnold, loc. cit.

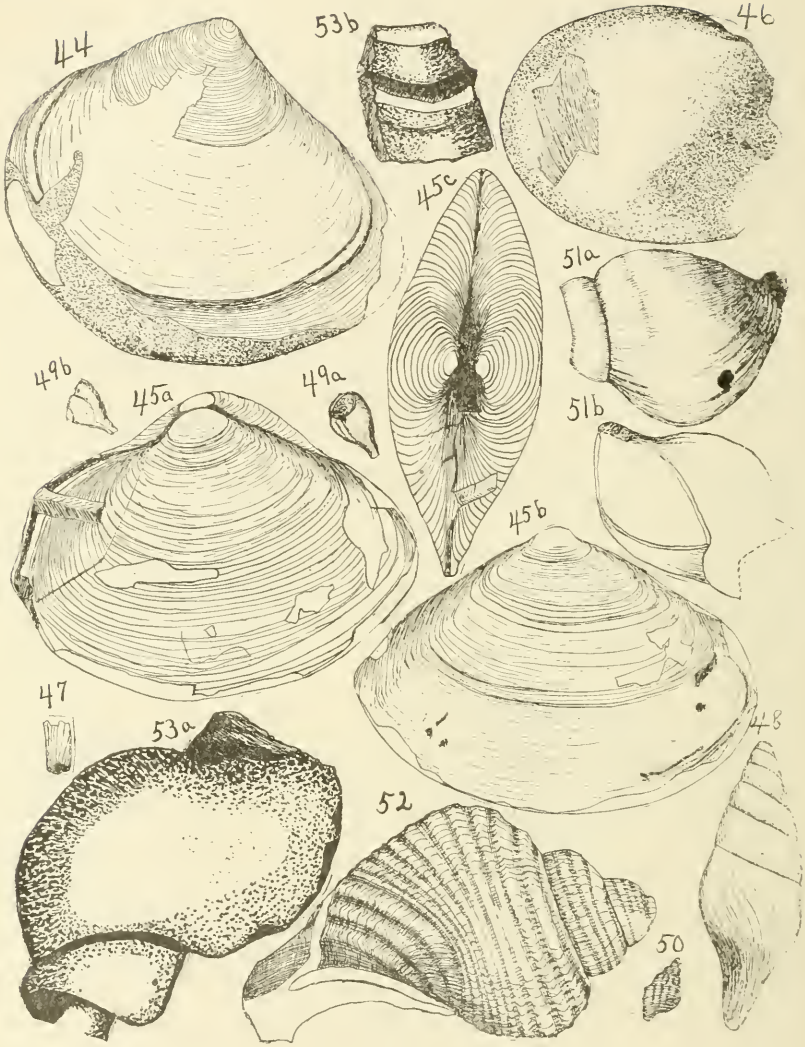

PLATE V.

FIG. 44. Mactra (Spisula) falcata Gould.
FIG. 45*a*. Mactra (Spisula) falcata?; right valve, showing umbones.
FIG. 45*b*. Left valve of same specimen.
FIG. 45*c*. Dorsal view of same specimen.
FIG. 46. Mya truncata Linne; a cast of a broken left valve; times, one-half.
FIG. 47. Cylichna alba Brown; a much broken specimen.
FIG. 48. Pleurotoma perversa Gabb.
FIG. 49*a*, 49*b*. Bela sanctæ monicæ Arnold?; specimen much broken.
FIG. 50. Bela fidicula Gould.
FIG. 51*a*. Buccinum bogachielii n. s.; a broken specimen.
FIG. 51*b*. An opposite view of 51*a*.
FIG. 52. Chrysodomus giganteus n. s.
FIG. 53*a*. Chrysodomus stantoni Arnold; a cast; times, one-half.
FIG. 53*b*. A fragment of the above specimen, showing the sloping tabular area.

Genus *Bela* Gray.

Shell oval, fusiform, thin; spire produced; canal short; sinus small, near suture; columella flattened; operculum pointed at both ends (Arnold). A characteristic species is *Pleurotoma turricula* Montf.

49. ?*Bela sanctæ monicæ* Arnold?. Plate V, figs. 49*a*, *b*.

Only a fragment of the body whorl of this shell was obtained. It had the characteristic sculpture of the above species; aperture not seen.

Fragment from the Quillayute formation.

50. *Bela fidicula* Gould. Plate V, fig. 50.

The classification of this species was made by comparing the specimen with specimens in the museum of the Leland Stanford Junior University.

Shell small, thin; spire elevated; apex subacute; whorls five (to seven), angular, forming a broad shoulder at the suture; surface ornamented with about sixteen prominent, subacute, axially arranged ribs, which extend from suture to suture, the ribs forming an angle forward across the table-like band to connect with the ridge in front of it across the suture on the next whorl above; surface also sculptured with spiral sulcations, which become spiral lines on the lower part of the body whorl to its lower extremity; a knuckle-shaped ridge begins at the notch in the lip and borders the tabular area in front of suture from lip to apex, caused by a slight elevation on each rib where it forms the angle to cross from whorl to suture; suture deeply impressed, distinct; aperture subelliptical; canal short; body whorl ventricose, without transverse sculpture on the lower part; pillar smooth internally; striate externally.

Dimensions: Axial length, 9; greatest lat., 4; height of body whorl, including canal, 6; of aperture, including canal, 6.

Distinguishable from *B. sanctæ monicæ* Arnold by smaller size and greater angulation of whorls.

The label with the specimens with which the specimen was compared stated that the shells were from the lower San Pedro series (Upper Pliocene) of California.

The specimen, the only one of the species obtained, was found among the Pliocene shells from Quillayute, Wash.

Family LVIII Buccinidæ; Genus *Buccinum* Linne.

Shell inflated, smooth, or transversely ribbed; spire moderately high; aperture wide; canal short, wide open; outer lip sharp, thin; inner lip somewhat callous.

51. *Buccinum bogachielii* n. s. Plate V, figs. 51*a*, *b*.

Shell oblong-ovate, thin; whorls convex, somewhat glassy in appearance; surface ornamented with rather fine lines of growth and with two faint spiral ridges on each whorl, separated from each other by about the space of a third of the whorl in longitudinal section, the upper ridge impression on each whorl being at the beginning of the area that forms the slope to the suture; aperture ovate; canal open, short.

The specimen is from the Quillayute formation. The species is rare.

Genus *Chrysodomus* Swainson.

"Shell fusiform, ventricose; spire elevated; whorls rounded; covered with a horny epidermis; apex papillary; aperture oval; canal short; inner lip simple, smooth." (Arnold).

52. *Chrysodomus giganteus* n. s. Plate V, fig. 52; times, one-half.

Shell very large, broadly fusiform; spire elevated; whorls seven or eight, convex, sharply angulate and keeped above, forming a rimmed, spiral table, below which there is a rather wide, flattened, second table-leaf-like, declining area, bordered below by a second prominent angular ridge, followed by another depressed area; then low lands alternating with slightly depressed spaces in a revolving manner cover the body of each whorl; surface smooth except for fine, nearly oblique, incremental lines which extend over the table-areas; suture impressed; aperture elliptical-subovate; outer lip thin: inner lip incrusted; canal wide, short, curved backwards; columella twisted, smooth.

Dimensions: Axial length, ?; lat. of body whorl of specimen figured, 71; of the next whorl, 38.5; height of body whorl from mouth of canal, 78; of the next whorl, 21.

Measurements of a medium-sized specimen: Lat. of body whorl, 56; of the next whorl, 33; height of body whorl from mouth of canal, 58; height of next whorl, 18; length of aperture, including canal, 53; width at widest part, 31.

This species is distinguishable from the other *Chrysodomus* species by its large size, smooth surface and double tabular area.

Specimen obtained from the Quillayute formation near the mouth of Maxfield creek, Clallam county, Washington.

53. *Chrysodomus stantoni* Arnold. Plate V, fig. 53.

Chrysodomus stantoni Arnold. Proc. U. S. Nat. Mus., 1908.

This species resembles *C. giganteus* above but differs from it in its having a more sloping primary table, nearly obsolete instead

of prominent spiral sculpture, straighter walls of whorls in vertical direction, and its having a sutural canal.

Specimen from the Quillayute formation.

Unidentified specimens of this species were found in Arnold and Hamilton's collection in the museum of the Leland Stanford Junior University from Purissima Rock, Punta, Anyo Nuevo, California; also in V. W. Bradley and L. D. Frink's collection from Newyear Point (Capitola), California; and Doctor Smith has just recently advised me that Doctor Arnold has identified the species as above, from a location in the Santa Cruz quadrangle, age Middle Pliocene.

Genus *Neptunea* Bolten.

Shell elongate-ovoid, inflated, sometimes sinstral, with rather short and sometimes bent canal; aperture oval.

54. *Neptunea maxfieldii* n. s. Plate VI, fig. 54.

Shell large, robust-fusiform, thick; spire elevated, subacute; whorls five or six, convex, the convexity being more pronounced on the upper part of the whorls; suture having a notched appearance caused by the shell of the previous whorl overlapping it in saw-tooth fashion, distinct, appressed; aperture oval-elliptical to subovate; outer lip curved in and flattened at edge near suture in mature specimens; inner lip incrusted; base of aperture where it meets the canal broadly rounded; canal short, slightly curved backwards and a little to the left; columella rough, twisted; surface smooth, with the exception of faint spiral sculpture which shows principally on the lower part of the body whorl, extending on to the external part of the pillar; transverse lines are also seen on the more mature specimens, but if they were ever prominent they have been weathered away; color of shell reddish.

Dimensions of largest specimen: Axial length, 70; lat., 47; aperture, including canal, 51 x 27.

This species differs from the *Tritonidæ* in the less prominent sculpture, especially the practical absence of the transverse lines and the total absence of the nodes so characteristic of the latter; also in the upper part of all the whorls being convex. Its shape is also more that of *Neptunea* than of *Cancillaria*.

The specimens representing this species were obtained at the present mouth of Maxfield creek near Quillayute.

54½. *Neptunea* sp.

A fragment of shell from the Quillayute (Pliocene) formation proves to belong to *Neptunea;* but is too much broken to admit of specific determination.

Family LXI MURICIDÆ. Genus *Monoceros* Lamarck.

"Shell ovate; last whorl large; spire rather elevated; aperture semilunar; inner lip wide and flattened; outer lip crenated, with a prominent tooth usually at the fore part. *Monoceros lugubre* Sow. is a characteristic species" (Arnold.)

55. *Monoceros engonatum* Conrad. Plate VI, fig. 55.

Monoceros engonatum Con., Jour. Phil. Acad. Sci., vol. VII, 1837, p. 264, pl. XX, fig. 17; (equals *M. unicarinatum* Reeve, Icon. Conch., Sp. I). Cpr., Brit. Assn. Rept., 1893, p. 663. Gabb, Pal. Cal., vol. II, p. 75, 1869. Tryon, Man. Conch., vol. II, p. 195, pl. LXI, fig. 304, 1880. Cooper, 7th Ann. Rept. Cal. St. Min., 1888, p. 251. Keep, West Coast Shells, p. 29, fig. 10, 1892. Williamson, Proc. U. S. Nat. Mus., vol. XV, 1892, p. 214. Arnold, Mem. Cal. Acad. Sci., vol. III, pp. 246, 247, 1903.

Arnold's description (see above): "Shell of medium size, fusiform; whorls six, angular, flattened to concave above and below: spirally sulcate, sulci with transverse lamellar striæ; suture deeply appressed, distinct; aperture subelliptical; outer lip effuse, dentate within; inner lip slightly flattened, smooth; canal deep, narrow, recurved; pillar twisted, squamose."

Dimensions (specimen obtained much broken): Axial length, more than 28; lat., 19; height of body whorl, including canal, more than 21.

A single specimen of this species was found in the Quillayute formation.

Living: San Diego to Baulinas Bay, California (Cooper).

Pleistocene: San Pedro, Ventura, San Diego, Lake Merced, San Mateo county, California (Arnold): San Pedro, San Diego (Cooper).

Pliocene: Old mouth of Maxfield creek, Quillayute, Wash. (Reagan).

Genus *Trophon* Montfort.

56. *Trophon* sp. Plate VI, fig. 56.

A fragment of a shell from the Quillayute formation proves to be of the above genus; but it is too much broken to admit of specific determination.

Subfamily PURPURINÆ; Genus *Purpura* Brugiere.

Shell oblong-oval, body whorl large, usually with transverse ribs or nodes; spire short in most species; aperture oval to ovate, large, terminating in a notch, or a very short oblique channel; columella flattened, smooth. A typical species is *Purpura persica* Linne.

57. *Purpura crispata* Chemnitz. Plate VI, fig. 57.

Purpura crispata Chemnitz, Conch. Cab., XI, pl. 187, figs. 1802 and 1803, 1795. Kuster, Conch. Cab., p. 105, pl. XIX, figs. 3 and 4, 1837. Carpenter, Brit. Assn. Rept., 1863, p. 662. Tryon, Man. Conch., vol. II, p. 175, pl. LXIII, figs. 163–166, 68, 1880. Cooper, 7th Ann. Rept. Cal. St. Min., 1888, p. 261. Keep, West Coast Shells, p. 33, fig. 13, 1892.[62] Arnold, Mem. Cal. Acad. Sci., vol. III, p. 261, 1903.

The specimen here figured and described is much broken and belongs to the variable class of this species.

Shell fusiform; spire much elevated; apex subacute; whorls five to seven, angulated with two prominent spiral ridges (now much worn) on each whorl with a flattened band-like space between them; suture impressed, distinct.

Dimensions: Length without canal, 23; lat. of body whorl, 17.

Only a single specimen was obtained from the Pliocene of the Quillayute formation.

Living: Sitka to Santa Barbara (Cooper); Neah Bay, Quillayute Bay, Washington (Reagan).

Pleistocene: San Pedro, Cal. (Arnold); San Diego to Santa Barbara (Cooper).

Pliocene: Quinaielt river, near Granville (Tahola), Wash.; San Pedro, Cal. (Arnold); Seven Mile Beach, San Mateo county, California (Cooper); Quillayute, Clallam county, Washington (Reagan).

58. *Purpura lapillus* Lam. Plate VI, fig. 58.

Specimen obtained is much weathered. Shell fusiform, of medium thickness; spire elevated; apex subacute; whorls six, convex; suture impressed; aperture oval-elliptical; inner lip and columella flattened; canal short; umbilicus slightly perforate to non-perforate; surface sculpture wholly removed, except transverse growth lines.

Dimensions: Lat., 16.5; axial length, 31.

Specimen from the Quillayute formation.

Living: Quillayute Bay and Puget Sound (Reagan).

Pliocene: Quillayute, Wash. (Reagan).

59. *Purpura lapillus*, var. *quillayutea*, n. var. Plate VI, figs. 59*a*, *b*.

Shell with elevated spire, extended beak, rounded volutions; volutions numbering five or six, with strongly marked suture lines, their full, rounded, ventricose forms relieving the sutures; aperture large, semilunar in outline, terminating in a narrow canal below; outer lip thick; inner lip incrusted; canal a little recurved; surface sculpture mostly removed, except very fine oblique lines of growth parallel to the apertural margin.

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62. After Arnold, loc. cit.

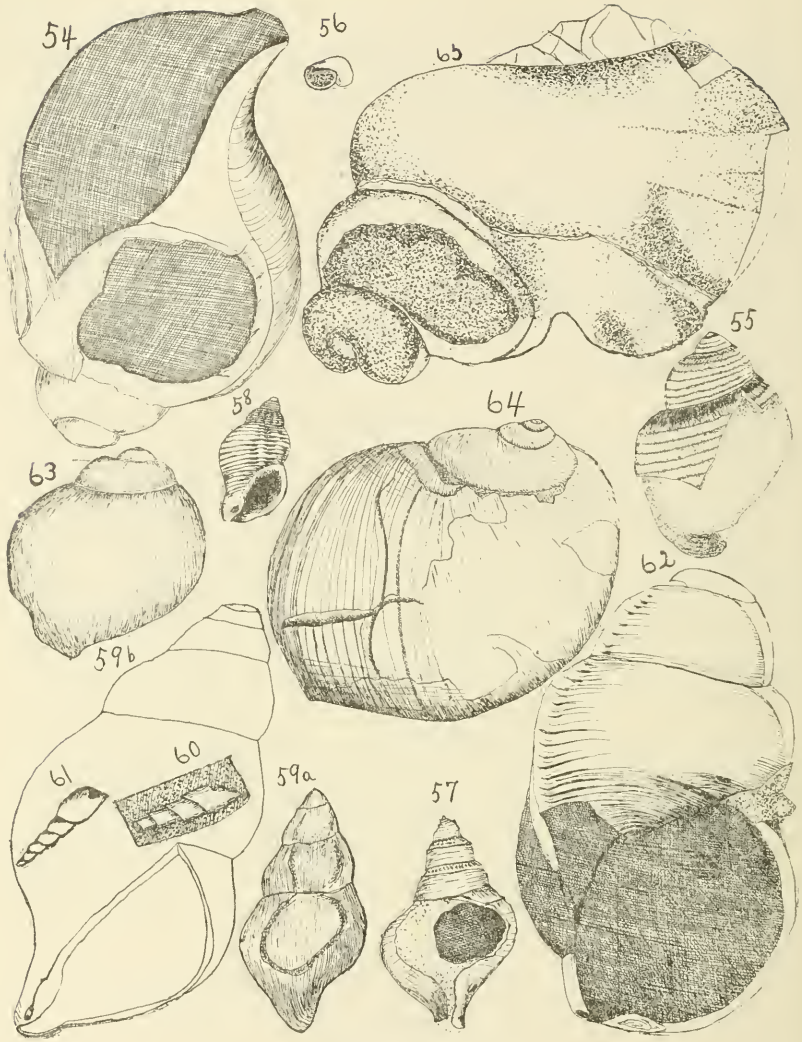

PLATE VI.

FIG. 54. Neptunea maxfieldi n. s.
FIG. 55. Monoceros engonatum Conrad.
FIG. 56. Trophon species.
FIG. 57. Purpura crispata Chemnitz.
FIG. 58. Purpura lapillus Lam.
FIG. 59*a*. Purpura lapillus, var. quillayutea, n. var.; showing rear view of a worn specimen; times, one-half.
FIG. 59*b*. Outline of same specimen, showing aperture.
FIG. 60. Eulima washingtoni n. s.; a cast.
FIG. 61. Eulima smithi n. s.; rear view of a cast.
FIG. 62. Ranella marshalli n. s.
FIG. 63. Natica (Cryptonatica) clausa Broderip & Sowerby; times, one-half.
FIG. 64. Polynices (Lunatica) lewisi Gould; times, one-half.
FIG. 65. Aporrhais (Arrhoges) quillayutensis n. s.

Dimensions: Alt. of body whorl, including canal, 40; width, 31: longest diameter of aperture, 33; transverse diameter, 18.

This variety is distinguishable from *P. lapillus* var. *saxicola*, by a less gibbous body whorl, by a smaller and more elongated aperture and by the canal being more extended and turned more backwards.

A single specimen was obtained from the Pliocene of the Quillayute formation at the old mouth of Maxfield creek, near Quillayute, Wash.

Suborder STREPTODONTA; Superfamily GYMNOGLOSSA.
Family LXIII EULIMIDÆ; Genus *Eulima* Risso.

Shell small, white, and polished; slender, elongated, with numerous level whorls; spire often curved to one side; obscurely marked on one side by a series of periodic mouths which form prominent ribs internally; apex acute; aperture oval, pointed above; outer lip thickened internally; inner lip reflected over the pillar, not umbilicated (Arnold). A characteristic species is *Eulima tortuosa* Adams.

60. *Eulimna washingtoni* n. s. Plate VI, fig. 60.

Shell small, elongated, not curved to one side, thin; spire very acute; whorls six to ten; suture distinct, impressed; aperture elongate-ovate; outer lip thin, rather arcuate.

Dimensions: Axial length of medium-sized specimen, 12; lat., 3.

This species differs from *E. micans* Carpenter in having its suture impressed.

It is a rare species in the Quillayute formation of Quillayute, Wash.

61. *Eulima smithi* n. s. Plate VI, fig. 61.

Shell resembling *Eulima washingtoni* above, but having rounder shoulders shown on the cases.

Superfamily TÆNIOGLOSSA; Family LXV TRITONIDÆ.
Genus *Ranella* Lamarck.

Shell with elongated spire, compressed, with two opposite varices which are continuous over all the whorls; aperture oval; canal short, recurved; outer lip crenulated; columella arcuated and crenulated or ridged. *Ranella spinosa* Lam. is a characteristic species.

62. *Ranella marshallii* n. s. Plate VI, fig. 62.

Shell large, broadly fusiform; spire elevated; whorls convex, each with two prominent, oppositely placed, rounded, rather reflexed varices, each forming a continuous varix from apex to base of shell: suture deeply impressed, distinct: aperture suboval: outer lip

thickened, ridged without; inner lip incrusted; canal short, a little recurved; surface ornamented with very fine, revolving lines (there are no signs of there ever having been any nodes on the shell).

Dimensions: Height of shell to top of third whorl, measuring from posterior extremity of canal, 57; to the top of the second whorl, 49; to the top of the body whorl, 39; width of body whorl, including varices, 42; of first whorl of spire, 37; aperture, 34 x 25.

This species is distinguishable from *R. californica* Hds. by its absence of nodes and rugose revolving ridges and non-denticulate outer lip.

A single specimen of this species was obtained from the Quillayute formation at the mouth of Maxfield creek by Mr. Henry Marshall, who kindly presented it to the writer, and after whom it is named.

Superfamily CERITHIACEA; Family LXXVIII NATICIDÆ.
Genus *Natica* (*Adanson*) Scopoli.

"Shell subglobular; spire slightly elevated; aperture half round; spiral columellar callous entering the umbilicus. *Natica canrena* Linn. is a characteristic species."

Subgenus *Cryptonatica* Dall.

"*Natica* with smooth calcarius operculum and an umbilicus entirely and smoothly filled with callous. *Natica clausa* Broderip and Sowerby is the type."[63]

63. *Natica* (*Cryptonatica*) *clausa* Broderip and Sowerby. Plate VI, fig. 63; times, one-half.

Natica clausa Brod. and Sby., Zoöl. Jour., vol. IV, 1829, p. 360. Zoöl. Beechey's Voyage, p. 136, pl. XXXIV, fig. 3; pl. XXXVII, fig. 6, 1839. Carpenter, Brit. Assn. Rept., 1863, p. 661. Gabb, Pal. Cal., vol. II, p. 77, 1869. Tryon, Man. Conch., vol. VIII, p. 30, pl. IX, figs. 65, 67–69, 73, 1886. Cooper, 7th Ann. Rept. Cal. St. Min., 1883, p. 253. Keep, West Coast Shells, p. 46, 1892. Arnold, Mem. Cal. Acad. Sci., vol. III, pp. 313 315, 1903.

Natica russa Gld., Proc. Bost. Soc. Nat. Hist., vol. VII, 1859, p. 43; Otia, p. 109, 1862. Carpenter, Brit. Assn. Rept., 1863, p. 586. Cooper, Bull. No. 4, Cal. St. Min. Bureau, part 3, 1894, p. 29.[63]

This species, as represented in the Quillayute formation, resembles *Lunatia lewisii* very much, except that the adults are much smaller and the spire more elevated in proportion to the size of the body whorl.

Shell ovate-globular; spire slightly elevated; whorls four, evenly convex to shouldered occasionally; surface ornamented by incremental lines only; suture depressed; aperture round-semioval to

63. After Arnold. See above.

semilunar; inner lip callous and reflected completely over the umbilicus; outer lip sharp.

A numerous species in the Pliocene of the Quillayute formation at the old mouth of Maxfield creek near Quillayute, Wash.; also on the Bogachiel river in the northeast bank near Mr. Earl Wilson's place, between Forks and Quillayute.

Living: North Atlantic, Arctic Ocean, Alaska (Cooper).

Pleistocene: San Pedro, Santa Barbara, Cal. (Arnold); San Diego to Santa Barbara (Cooper); Fish Point, Lummi peninsula, Whatcom county, Washington (Reagan).

Pliocene: Santa Barbara, San Pedro, Cal.; mouth of Quinaielt river near Granville, Wash. (Arnold); Quillayute, Wash. (Reagan).

64. *Polynices* (*Lunatia*) *lewisii* Gould. Plate VI, fig. 64; times, one-half.

Natica lewisii Gld., Proc. Bost. Soc. Nat. Hist., 1847, p. 239; Wilkes's Expl. Exped., 211, pl. XV, p. 253, 1852.

Lunatia lewisii Gld., Cpr., Brit. Assn. Rept., 1863, p. 661. Gabb, Pal. Cal., vol. II, p. 77, 1869; equals *N. reiniana* Dunker and *N. algida* Gld. (See Tyron, Man. Conch., vol. VIII, p. 35, pl. XIII, figs. 11, 12; pl. IX, fig. 70, 1886.) Cooper, 7th Ann. Rept. Cal. St. Min., 1888, p. 247. Keep, West Coast Shells, p. 45, fig. 25, 1892. Dall, Trans. Wagner Inst. Sci., vol. III, part II, 1892, p. 374.

Natica (*Lunatia*) *lewisii* Gld., Williamson, Proc. U. S. Nat. Mus., vol. XV, 1892, p. 211.[64]

Polynices (*Lunatia*) *lewisii* Gould, Arnold, Mem. Cal. Acad. Sci., vol. III., pp. 315, 316, pl. X, fig. 14.

Shell very large, globose, conic; spire elevated, acute; whorls four to six, slightly convex, well rounded; body whorl large, having a long, slightly convex slope from suture to near the base, where it suddenly turns under the umbilicus; aperture ovate, broad, having a sharp lip on right margin; on the left margin the lip widens and presents a rounded edge; umbilicus moderately long, deep, nearly round; operculum thin, horny; upper whorls more concave than body whorl; whorls separated from each other by suture.

Dimensions: Adult specimens range from 70 to 100 mm. or more in axial diameter, and 60 to 80 mm. in transverse diameter. Some specimens are still larger.

Living: Discovery Harbor, Oregon, Puget Sound (Pickering); Quillayute Bay, Neah Bay, Washington (Reagan); Strait of Fuca to San Diego (Cooper); Japan (Tryon); Catalina Island (Arnold).

Pleistocene: San Pedro, Cal. (Arnold); San Nicolas Island, Santa Barbara, Cal. (Cooper).

Pliocene: Santa Barbara, Kirker's Pass, San Fernando, Cal. (Cooper); Soquel, Santa Cruz county, California (Arnold); Quillayute, Wash. (Reagan).

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64. After Arnold, loc. cit.

Family APORRHAIDÆ; Genus *Aporrhais* Dillwyn.

Shell fusiform, turreted or oblong-ovate, with a short canal in front and a posterior canal running up the spire; outer lip of adult shells expanded and two or three digitated, digitations forming carinæ on the back of the shell.

Subgenus *Arrhoges* Gabb.

"Shell with expanded lip, merely terminating in a single posterior obtuse, lobe-like extension, and having its anterior sinus nearly or quite obsolete; posterior canal very short; anterior canal also short and obtuse."[65]

65. *Aporrhais* (*Aporrhoges*) *quillayutensis* n. s. Plate VI, fig. 65.

Volutions five or more, convex; suture distinct; body whorl large, thick; lip expanded, terminating in a single posterior large, lobe-like extension; anterior sinus nearly obsolete; posterior canal very short; anterior canal short and obtuse; surface sculpture unknown (a few fragments of the shell on the cast seem to indicate that it was smooth); inside of outer lip ridged, the ridges radiating outward.

Dimensions: Axial length, more than 60; breadth of body volution, including lip, 45; extension of lip, 21.

A single specimen was obtained from the Quillayute formation at the mouth of Maxfield creek.

This species differs from all previously known *Aporrhais* in its large size.

PLEISTOCENE STRATIGRAPHICAL SECTIONS.

1. Section taken at Port Townsend:

1.	Blue clay	10 feet +.
2.	Plaster sand	30 "
3.	Yellow and containing cobblestones	4 "
4.	Black soil	2 "

In 2 and 3 large glacial boulders are embedded.

This is the only section taken on the strait; those which follow are from the Pacific side.

2. A section in a well on the Pool place on Quillayute prairie taken from the surface down:

1.	Black loam	3 feet.
2.	Yellow and blue clay	20 "
3.	Gravel	67 "

No water was found in this well. The Quillayute prairie lies on a bench, and its greatest drawback is its lack of water.

65. Meek, U. S. G. S. Terr., vol. IX, p. 321.

3. A section in Mr. E. Pullen's well on Quillayute prairie:

1. Clay and sand; sand at bottom of well; plenty of water..... 24 feet.

4. A section in Mr. Maxfield's well on Quillayute prairie:

1. Loam ..... 4 feet.
2. Yellow clay ..... 7 "
3. Layers of loose gravel and of partly "cement" gravel..... 20 "

This well has a little water in it; but it seeps away in the gravel. The well has been abandoned.

5. A section in Mr. Peterson's well on Forks prairie:

1. Gravel, hard-pan, clay including boulders ..... 75 feet.

In this well, as in all the wells of Forks prairie, there is plenty of water. It is obtained from the seepage from the Calawa river. From the big bend in that river, its volume is much diminished. Its water passes beneath Forks prairie as an undercurrent and has its exit below the prairie in numerous springs, the water ultimately reaching the Bogachiel river. This water seems to follow the old channel of the Calawa prior to glacial times.

6. A section at Forks prairie on Mill creek, at the falls at Mr. Iverson's sawmill:

1. Loam ..... 2 feet.
2. Yellow clay ..... 4 "
3. A yellow cement cobblestone stratum, causing the falls in the stream..... 4 "
4. Laminated, horizontal to the cross-bedded, massive, coarse to gravelly sand containing small cobbles—stratum totally unlithified..... 10 feet +.

7. A generalized section from Quillayute prairie to Dickey lake:

1. Gravelly soil ..... 2 feet.
2. Yellow clay. This clay digs easily as a rule. At places, however, it has a "gumbo" nature, at others a jointed structure. Where stumps had been burned it was noticed to be oxidized, being bright red in color. It seems to be a good brick and tile clay. The boulders in it attest its glacial origin. Maximum thickness..... 20 "
3. Blue clay, exposed under the yellow clay stratum along the streams. This clay when wet is sticky, and gives off a bad odor. The water that seeps from it also has a bad taste. It is typical ground moraine material. In this clay, as in the yellow clay above, there are lenses of gravel. Strata of fire-clay were also seen in the bluffs occasionally ..... 40 feet +.

Description of formation.

The Pleistocene deposits separate themselves into two groups—those exposed along the strait and those exposed along the Pacific front. Below is a description of each:

Deposits of the Strait Region.—These deposits extend from Port Townsend all the way to Neah Bay, but are exposed only in patches on the coast west of Gettysburg. The formation is of glacial origin and extends to the islands off the coast; in the formation on Protection Island many swamp stages are represented. The formation reaches its maximum thickness along the strait from Port Townsend to Gettysburg, it there being from 200 to 300 feet in thickness. Westward from Gettysburg it thins out to a mere edge. In the interior here, however, there is an abundance of evidence of glaciation at every place examined north of the northern extension of the Olympic axis; granite boulders were found 800 feet above sea-level near the top of the divide on the La Push-East Clallam wagon-road. Towards Neah Bay there are several preglacial streams filled with Pleistocene deposits that have not been recut since then; and almost all of the preglacial streams there have a wedge of Pleistocene material in the old channel on each side of the present channel. One glacial-filled channel about six miles west of the Sekiu river has a large number of granite boulders in it. The formation at its maximum-development localities has its lower member till, a stiff blue clay—probably the equivalent of Willis's Admiralty till of the Puget Sound country. The rest of the formation is roughly stratified sand and gravel.

From the material at hand, it would seem that the northern glaciers, coming against the rock walls of the Olympics in their southern advance, were compelled to dump their debris on the low lands and in the south margin of the strait depression along their front from Puget Sound west to Gettysburg, though it is probable that the deposits were augmented here by increment from the Olympic glaciers. But from Gettysburg westward, on account of a lowering of the land surface, which will be mentioned later, they passed over the western axis to the Pacific, not only not depositing much material on the strait side but in many places even scraping the rocks bare of all soil, and, passing over the divide, broke off its top, dumping the whole of its debris in the Quillayute-Ozette trough and on the ocean front beyond.

Deposits on the Pacific Front of the Peninsula.—In Pleistocene times the whole Pacific front of the peninsula was submerged or partly submerged from Waatch Strait to some distance below

Point Granville. In the north even the ridge (islands) along the southern margin of the Quillayute-Ozette syncline were submerged, and the sea claimed as her own all the present land surface to the very foot of the western extension of the Olympic axis. Marine shells are found at Beaver post-office, twenty miles inland, as well as in the stratified sands thirty-five feet above tide along the ocean front near Point of Arches. After the subsidence there came from the northward over the divide the great glacier, and, having scraped off the top of the northern country, dumped its accumulated debris in the pounding seas, extending its front outward beyond the present shore-line and the now off-shore islands, probably even as far out as the halibut banks, they likely being the final dumping-ground. And by its advancing and retreating and the working over of the material by the sea, the whole region, far beyond the present shore-line, was filled up to a level with the top of the now off-shore islands and to a height considerably above the former height of the islands and former coast-line, as all are capped with from forty to sixty feet of glacial material. Also, above the submerged area, the now eastern tributaries of the Quillayute river had their inner valleys submerged or under tidal influence far inland from the then shore-line and glacial-sheet. Consequently, they there sedimented up their channels; Pleistocene deposits were found to underlie the present bed of the Soleduck river, even as far as the Soleduck hot springs, though for many miles below that it has now removed the greater part of these deposits.

That the glacier which glaciated this region as far south as the Hoh river came from the north is attested by the fact that the upper country of the Quillayute valley shows no signs of having been glaciated; also the granite boulders seen in the deposits near Ozette lake and at many other places along the coast and in the interior region are apparently rock from the Selkirks and Mount Baker, far to the northward; there is no granite in the Olympics.

On the whole, the formation west of the Hoh river is composed mostly of sand and a poor grade of gravel, made up mostly of ground-up sandstone from the neighboring hills, with a few granite boulders scattered here and there. It reaches a thickness of 125 feet at Yellow Banks on the coast five miles east of the Ozette Indian village; but in the center of the Quillayute-Ozette it is likely much thicker. At the surface it presents the characteristic features of a glaciated region, subdued by the effects of a receding sea. Near Mr. Albright's place, near Dickey lake, overwash sand and gravel were found. McCalley lake, in section 20, having an area

of about forty acres, besides a large swamp district surrounding it, seems to be a scooped-out area of glacial origin. In the vicinity of Mora and in the lower Dickey river country there are several kettles.

In the Hoh valley and from there southward the glacial debris seems to have all come from the Olympic glaciers. Its thickness and extent were not ascertained.

As a closing remark, the islands now off the Pacific coast of the peninsula were islands in pre-Pleistocene times, the same as now, with the addition of many of the present headlands. In the Pleistocene epoch they were submerged, or partly so, and then completely surrounded and covered over with debris from the glaciers and streams of the adjacent region. At the close of the epoch the country was again elevated; and the land surface was then extended farther out to sea than the present off-shore islands. Since then the sea has been continually tearing down the loose Pleistocene material and carrying it out to deeper water areas; and the resistant rock (the original islands) are made islands again as fast as the sea can remove the debris—islands the same as before, except that they now have a Pleistocene cap. And the eroding work is still going on. In front of the writer's residence the sea has encroached upon the land 300 yards in four years; and the waves now rule supreme where the Indian village stood only ten years ago. In the revolving years many of the present headlands will have all the loose material removed from around them, and they too will be islands.

Recent Deposits.—These are found in the deltas of the respective streams and in a part of the lower inner valleys of the Quillayute and Pysht rivers, and in the Waatch Strait-Suez river region west of Neah Bay. In these localities, the under rock is usually sand or gravel, or both. The surface stratum is usually a rich loam, and the areas it covers good farming districts. A part of Waatch-Suez area is semi-tide lands, and some of it is being encroached upon by beach sands, which are being continually blown inland by the prevailing southwesterly wind which sweeps the region. The construction of a dike to keep the sea out, and of a windbreak to stop the sand-dune encroachment, has been requested of the Interior Department for the benefit of the Makah Indians, in whose reservation the area lies.

As a closing remark on the structural geology of the region, quoting from Doctor Arnold:[66] "A great uplift in the Olympic

66. Bull. Geol. Soc. Am., vol. 17, p. 468.

Peninsula region appears to have taken place at or near the close of the Miocene epoch,[67] and still another lesser one during the late Pliocene. That orogenic movements are still taking place, or have occurred since the deposition of the Pleistocene, is evidenced by the very gently folded and tilted clays, sands and gravels in the vicinity of Port Angeles."

ECONOMIC GEOLOGY.

Sand and Gravel.

The gravel, though not a first-grade quality, is practically unlimited in quantity. The best grade is found on the strait side, but any of it is good road-building material, and is now being used for that purpose. And when the railroads once enter the region there is gravel enough in it to make the grades and keep the roads ballasted after completion.

The sand in the west end of the peninsula is a limited quantity, being confined principally to the beach districts; but fronting the strait from Gettysburg to Port Townsend it is practically inexhaustible in quantity. Where found it is a good plastering and street-paving sand.

Building Stone.

The sandstone of the Clallam formation and the sandstone of the Olympics would make good building material, but as yet there is no demand for stone in the region, and likely will not be for many years to come.

Iron Ore.

In the region back of Port Townsend, on the Puget Sound side, there are said to be mountains of low-grade iron ore ; also extinct swamps containing this metal. There were iron reduction works in this region once, but the ore there is said to be so poor in grade that the ore used was imported from the Canadian side. This iron-ore region was not visited by the writer.

Gold Placers.[68]

As yet the interior of the Olympic region has not been prospected; but many quartz veins in the mountains and in the Clallam Peak country are known to carry gold. Some in the latter region are said to carry it in paying quantities. At the present time, however, the only gold-mining carried on is that of placer mining along the Pacific beach; and it only pays in spots. The principal

67. Should the Quillayute formation prove to be Upper Miocene, then there were two periods of uplift in the epoch—one at the close of the Clallam stage and the other at the close of the Quillayute.

68. Also, see Arnold, U. S. Geol. Bull. No. 260, pp. 154–157, Gold Placers of the Coast of Washington.

locations are at Shishi Beach, between Point of Arches and Portage Head; at Ozette Beach, near the village of the same name; at Yellow Banks five miles south of the Ozette Indian village; and at a point on the beach some two miles northwest of Johnson Point and six miles northwest up the coast from the mouth of the Quillayute river.

In 1894 came the first gold excitement of the region, it being reported at that time that gold could be found in the beach sands almost anywhere from Gray's Harbor to Cape Flattery. A rush followed, and most of the beach was staked from Cape Flattery south nearly to the mouth of the Columbia river. Pay sand, however, has been found only at the locations above mentioned.

The gold, which is usually in small flakes, is always associated with "black" and "ruby" sands. It seems to have been concentrated at the base of the bluffs along the coast at or near bed-rock by a process of wave action, from the Pleistocene deposits capping the bluffs. In separating this metal from the sand and gravel in which it is found the sluice-box method is used wherever there is sufficient water; at other places rockers are used.

Mr. W. W. Lovelace, the owner of the Shishi placers, states that his claims have produced $15,000 in gold; and it is likely that the other claims along the beach taken together have produced a like sum.

Shishi Beach Placers.—Shishi beach extends from Point of Arches to Portage Head. This beach had furnished the richest claims on the coast up to this present year, when it was eclipsed by the placers near Johnson Point. In this district the beach claims are now mostly worked out; but recently paying placer ground has been found on the bench inland from the beach. Along this beach a low bluff of gray shale and fine gray sandstone meets the incoming tide. Superimposed upon this are yellow sands and gravels of Pleistocene age, while the beach at high-tide line is strewn with cobbles and pebbles, mostly derived from the Pleistocene deposits through the action of the encroaching sea. The rest of the beach is covered mostly with sand from one to four feet in thickness. It is in this sand and in the crevices of the underlying sandstone and shale that the gold is found. Mr. Lovelace states that he removes several inches of the bed-rock and sluices it with the sand when washing for gold on this beach.

Ozette Placers.—Along the beach at Ozette gold occurs in the sand the same as at Shishi; but on account of a lack of water but little work has ever been done. Before placer mining can be suc-

cessfully carried on in this district water will have to be brought from Ozette river or lake.

Yellow Banks Placers.—Six or seven miles south of Ozette the Pleistocene deposits overlook the sea in yellowish-brown bluffs reaching a height of over 125 feet. No bed-rock is here exposed; only horizontally bedded Pleistocene sand and gravel. At the base of the bluffs are pay sands, a concentrate from material that is being continually dropped from the cliffs. Here there is an abundance of water, thus enabling the miners to use the sluice-box method of separation. Work was done in this district last year but it is now temporarily abandoned.

Johnson Point Placers.—Last winter gold was found in the beach sands near Johnson Point, also in paying quantities in the Pleistocene deposits of the bench adjacent. Since then several men have been employed at placer mining in the district; but the work is very badly hampered by flooding caused by the encroaching sea. A pan of sand here has been known to run as high as sixty cents in gold; and men have been able to clear from two to ten dollars per day. The gold consists of very fine flakes. Associated with it are magnetite, garnet, pyrite, platinum, and iridosmine.

Remarks.—The first gold excitement in the region occurred in 1894. Since then placer mining has been carried on continuously, some $30,000 having been taken from the district.

The gold is unquestionably derived from the Pleistocene deposits covering the benches adjacent to the sea, being concentrated at bed-rock at the base of the bluffs and benches by the pounding sea-waters. The gold being derived from the Pleistocene deposits, there seems to be no reason why pay gold may not be found in certain localities in these deposits as well as in the beach sands. And again, as the sea in Pleistocene times reached far inland to what it does now, it is possible that gold concentration was going on along the ocean front then as now, and that pay streaks may be found along the then ocean beach. Moreover, all the gold not brought with the glacier from the Selkirks and Mount Baker country must have been leached out of the mineral veins in the Clallam Peak district. Consequently, rich veins of gold ore may some day be discovered in that region.

Oil.

As has been casually mentioned, there are indications of oil at several places along the Pacific coast from Cape Flattery to Point Elizabeth. The conglomerate and serpentine of the supposed pre-Cretaceous series give off an odor like that of benzine, when freshly

exposed, though it is quite likely that they obtain their oil from the Miocene shales adjacent by a seepage process. The supposed Cretaceous rocks in many places also give off a similar odor, and oil seepages are known to occur at several locations along the coast where these rocks are the country rocks. It is also likely that they, too, have derived their oil by seepage from the Miocene shales which they rim.

As has been seen, the Miocene series rims the Quillayute trough, and on the south side of this trough, where the older rock has been removed by the invading ocean, it forms cliffs facing the sea, being separated from the older rock by an erosive period and having its basal member a conglomerate rock of from 100 to 400 feet in thickness. The greater part of the series exposed is shale, but occasionally there are massive to thin-bedded strata of soft gray sandstone; and in the interior the whole series is capped with the sandstone of the Quillayute formation, which seems to be an equivalent of the lower Purissima of California. Wherever this Miocene formation is exposed there are oil indications, either in the occurrence of the odor of benzine or an allied product of crude oil, or in seepages. The latter are most prominently developed along the coast from the mouth of the Hoh river to the mouth of the Quillayute river. On Hoh head, near the mouth of the former stream, oil forms in pools so that one may dip it up with a cup. This oil is said to be one of the best grade oils ever found, having a forty-five per cent. paraffin base.

An oil-well was sunk on the very rim of this field to a depth of about 600 feet at a point some two miles south of the mouth of the Quillayute river in 1902, but the side pressure was so great that it caved in the pipes, and the work had to be abandoned without any oil having been obtained. A Quillayute oil company, representing people at Coalinga, Cal., is now preparing to put down a well near the old site next year. The Standard Oil people have also become interested in this field, and have now leased as much of the Forks prairie and Quillayute country as they can get at ten per cent. of the oil developed, agreeing to commence operation within three years from last summer.

It is the writer's opinion that the Standard Oil people have the best field; the seepage along the upturned broken edge of the formation along the coast is only an indication of the oil in the less-disturbed interior region.

If indications are criteria to judge by, there is an abundance of oil in the region south of the western extension of the Olympic axis.

Coal.[69]

As has been incidentally mentioned, there are indications of coal in all the sedimentary rocks west and north of the Olympics, especially in the sandstone series of the formations. As has been noticed, small veins of poor-grade coal were found exposed in the cañon walls of both the Hoko and Sekiu rivers. In the supposed Cretaceous rocks below Portage Head on the Pacific coast, small veins of black lignite were seen interbedded with the gray sandstone, the veins varying from stringers and fragments to seams several inches in thickness, the latter being exposed only at low tide. In the sandstone series of Johnson and Strawberry Points, small seams of coal are exposed, the coal seams being thicker and the coal a better grade the farther inland the exposures are found. A few miles up the Quillayute river from its mouth, a coal seam is found running in an east and west direction with nearly a vertical dip. The coal is a good grade of lignite, but the vein is less than a foot in thickness. Coal has also been found at the headwaters of the Quillayute river, at Freshwater Bay and at Clallam Bay. The last three coal areas are extensive, the coal a good quality of lignite, and in quantity sufficient to be workable.

Quillayute River Field.—A coal outcrop occurs about three miles above Salalet, or six miles from Forks, near the Bogachiel river. About fifteen years ago a railroad company, said to be The Narrow Gauge Railroad Company, spent considerable money tunneling into it. The tunnel was driven thirty feet. The coal-vein was about one foot in thickness, coal a good quality of lignite. After merely prospecting, the work was abandoned.

An analysis of coal from the headwaters of the Quillayute river, Washington, likely from the above mine, gave the following:[70]

Moisture	5.10	per cent.
Valatile combustible matter	39.15	"
Fixed carbon	47.01	"
Ash	7.77	"
Sulfur	.97	"
Total	100.00	per cent.

From indications this section will undoubtedly be a valuable coal-field when developed.

Freshwater Bay Field.—Arnold's description:[71] "The eastern-

71. Loc. cit.

most locality in (Clallam) county at which prospecting operations

69. Also see Arnold, Coal in Clallam county, Washington, U. S. Geol. Bull. No. 260, pp. 213-221.

70. Loc. cit., p. 417. Also, Bethune, Geo. A., Mines and Minerals of Washington; Ann. Rept. First State Geol. Surv., pp. 15, 16, Olympia, 1891.

for coal have been carried on is in the region about Freshwater Bay, seven miles west of Port Angeles. As before mentioned, this field lies just to the south of the bay, on the northeastern portion of a broad synclinal trough. The only evidence of coal found by the writer (Doctor Arnold, also by myself) along the beach of Freshwater Bay was on the eastern side, about one and one-half miles east of Observatory Point. Here a twenty-five foot series of hard, alternating gray and brown, thin-bedded sandstone strata outcrops between the fine, gray, sandy shale, which is exposed for some distance along this part of the beach. The sandstone dips south fifty degrees west at an angle of twenty degrees, and is full of more or less altered fragments of wood, some of which are six inches in length, and most of them full of teredo borings."

Mr. D. J. O'Brien, former superintendent of the Port Angeles Coal and Coke Company, and now president of the Clallam Bay Coal Company, prospected this field with a diamond drill, and kindly furnished Doctor Arnold with the following drilling record from a hole in a deep gulch about one-half mile south of the eastern end of Freshwater Bay, top of hole approximately at sea-level:[72]

	Feet.	*Inches.*
Dark sandstone	39	8
Coal	0	4
Gray sandstone	24	0
Soft white sandstone	17	0
Sandstone containing oyster shells	10	0
Sandstone containing green boulders	10	0
Sandstone	40	0
Fire clay	20	0
Gray sandstone	40	0
Hard blue shale	30	0
Gray sandstone	50	0
Coal	2	2
Gray sandstone	240	0
Coal	4	8
Totals	527	10

No development work has ever been done in this field.

Clallam Bay Field.—As was stated when the geological formations of the strait region were discussed, the Clallam Bay coal-field lies in a syncline between Pillar Point and Slip Point at the entrance of Clallam Bay. This syncline has a northeasterly-southwesterly axis. At the north it is truncated by the Strait of Fuca. It extends inland for a distance of more than seven miles, but is interrupted on the east and south by sharp local faulting. In it the coal-bearing formation consists of 600 feet of coarse, thick-bedded,

72. Loc. cit., p. 418.

massive sandstone, interbedded with an occasional stratum of conglomerate. In it are interbedded several workable seams of coal.

This coal-field was visited by Prof. J. S. Newberry, while a member of one of the Pacific railroad surveying parties. He obtained specimens of coal from a vein near Slip Point. Of this coal he gives the following analysis:[73]

Fixed carbon	46.40	per cent.
Volatile matter	50.97	"
Ash	2.63	"
Total	100.00	per cent.

In 1864 or 1865 a prospect was opened in the sea cliff two and one-half miles east of Slip Point.[73] Concerning this old mine, Mr. S. C. Gilman, in his article on the Olympic country, has this to say:

"Between Pillar Point and Clallam bay, on the Strait of Fuca, is the abandoned Thorndike coal-mine. There are said to have been 'six leads of coal, ranging in thickness from one to three feet, dip ten degrees; distance from coal leads, 12 to 100 feet; formation, sandstone.' This is said to have been one of the best coals found in Washington. It was mined for some time, until it pinched out or was cut off by a fault, and the vein was lost and the work abandoned."[75]

Quoting from Doctor Arnold:[76] "The remains of the old pier from which the coal at the mine was loaded onto schooners were still visible in 1892, when Mr. J. S. Diller visited the locality. The location of the mine is given on the Coast and Geodetic Survey chart (No. 6300) as two and one-half miles east of Slip Point, Clallam Bay. Mr. Bailey Willis also mentions the occurrence of coal measures on the Clallam and Psyche (Pysht) rivers in his report on the coal-fields of Washington territory."[77]

The real prospecting and development work in the region dates from about 1904. At this time Mr. O'Brien, of the Port Angeles Coal and Coke Company, above mentioned, made a thorough investigation of the section of country lying between the Pysht and Clallam rivers and the strait coast, finding workable coal-seams as follows: One four miles inland and one seven miles inland, and three on the ridge facing the strait between Pillar Point and Slip Point; one seam exposed on the coast being 40 inches in thickness, another 80 feet stratigraphically below this one of 12 inches in thickness, and the other, a 22-inch seam, in the neighborhood of

73. Pacific Railroad Report, vol. IV, part II, p. 67.

74. Landes, Henry, The Coal Deposits of Washington: Ann. Rept. Washington Geol. Surv., vol. I, 1901, p. 258.

75. Nat. Geog. Mag., vol. 7, 1896, p. 139.

76. Loc. cit., p. 417.

77. Tenth Census, vol. 15, 1886, p. 760.

100 feet above it. And recently a slide on the strait front has exposed a six-foot vein about a half-mile from the 40-inch outcrop.

Upon finding coal in the region, Mr. O'Brien organized the Clallam Bay Coal Company, leased the land in the coal region at a very reasonable per centage, and at once began development work on the forty-inch vein. At the present time the main tunnel has been driven 600 feet, the mouth of the tunnel being on the beach, so that coal is loaded right onto ships from it. The monthly output now is about 200 tons; and work on the newly discovered six-foot vein is to be commenced at once.

The coal is a clean, hard, glossy black lignite. It breaks with a conchoidal fracture and shows extremely sharp edges. It contains small quantities of pyrite, often in veinlets; but not in quantity sufficient to damage the coal. When burned the coal leaves no clinkers. An analysis of a surface specimen of this coal by Prof. N. W. Lord, of the department of metallurgy and minerology, Ohio State University, Columbus, Ohio, gives the following:

Moisture	6.55 per cent.
Volatile combustible matter	34.25 "
Fixed carbon	47.80 "
Ash	11.40 "
Total	100.00 per cent.

Sulfur, 6.37 per cent.

Mr. M. R. Campbell, of the United States Geological Survey, who is a member of the committee in charge of the government coal-testing plant at St. Louis, has this to say regarding the Clallam Bay coal:[78]

"I know of no use for which it may successfully compete with other coals that reach the Pacific coast; but, judging from the results which have been obtained at the government coal-testing laboratory at St. Louis during the past summer, I feel sure that the black lignite represented by this sample, although only three feet in thickness, may have considerable value. Tests made on similar lignite from the Rocky Mountain states show that it will produce gas of a higher power than that obtained from any bituminous coals of the Mississippi valley, and if gas-producers and gas-engines replace the ordinary type of engines, which seems altogether probable, it will give to this lignite a value almost, if not quite, equal to the best bituminous coal."

Recently twenty tons of this coal was sent to the government officials at Bremerton navy-yard near Seattle to have a test made of its qualities. This test, which has just been completed, shows a coal superior to any other coal produced on the Pacific coast.

78. See Arnold, loc. cit., p. 420.

THE CARBONIFEROUS QUADRUPEDS.

THOSE OF KANSAS, OHIO, ILLINOIS, AND PENNSYLVANIA IN THEIR RELATION TO THE CLASSIFICATION OF THE SO-CALLED AMPHIBIA AND STEGOCEPHALA.

By Roy L. Moodie, Assistant in Zoology, University of Kansas, Lawrence.

THE earliest quadrupeds known, as diverged into distinct types, have been called the amphibian and the reptilian. It is often difficult, if not at times impossible, to draw the line between these two large groups of animals. Before men had gone deeply into the study of paleontology these two groups were considered small and unimportant, but now that we know more than two dozen orders of reptiles, mostly extinct, and some nine orders have been assigned to the Amphibia, that opinion is no longer held, and we realize that the amphibians and the reptiles were dominant on the earth, among vertebrates, in late Paleozoic and throughout the entire period of the Mesozoic. Just what constitutes a reptile and an amphibian no one is so bold as to state at the present day, but we are warranted in making suggestions as to what seems right in the light of our present knowledge. On this basis we will assume the right of discussing the classification of one of these large groups—the one usually known as the Amphibia—which we shall see is a most heterogeneous assemblage.

The Carboniferous rocks of Kansas, Ohio, Illinois and Pennsylvania—and I doubt not those of West Virginia, Iowa and Indiana will also be found to contain them—contain the remains of vertebrates which are of a higher type than the fishes. The remains as they are preserved to us usually represent small creatures, although we occasionally find fragments which show that larger individuals existed at this time also. We will cite as instances of this the two large vertebræ named by Professor Marsh as belonging to *Eosaurus acadianus*, and a large rib to be described by the writer, a portion of a large skull designated elsewhere by the writer as *Macrerpeton huxleyi* Cope (formerly described as *Tuditanus huxleyi* Cope), and various fragments recently described by Case as pertaining to an unknown species of *Eryops;* as well as the large fragment of a tooth which Williston described in 1897 from near Louisville of this state. He was able to show from the microscopic structure of the tooth that the form was an undoubted labyrinthodont, which he allied with *Mastodonsaurus.*

The localities in the various states under discussion in which these early quadrupeds have been found are, in Kansas, Louisville and near Winfield; in Ohio, the famous Linton mines; in Illinois, the Mazon Creek beds; in Pennsylvania, Cannelton and Pittsburg. Three other states of the Union have furnished other remains, but they are not worthy of mention in this connection. Nor are the footprints discovered and partially described by Professor Mudge from Kansas, and by Lea and King from Pennsylvania, of sufficient diagnostic value to warrant consideration here. Since the creatures from the Mazon Creek beds in Illinois and the Linton, Ohio, mines have furnished the most complete material, we will confine our discussion in large part to them.

Among the several hundred specimens of the early quadrupeds collected by Dr. J. S. Newberry at the Linton mines, none is perhaps more remarkable than the one first described by Doctor Wyman in 1858 as *Raniceps* (*Pelion*) *lyelli*. Doctor Wyman and, later, Professor Cope, who studied the same specimen, called attention to the decided frog-like aspect of the skull, and indeed the comparison is a very striking one. It is barely possible that this species (plate I) may represent a form of the ancestral group from which our modern frogs have descended, although we have no direct evidence on this subject, since the form of the present specimen is preserved merely as a mold in the soft coal. There is present in the specimen a portion of the right hind limb, which is strikingly frog-like, and this tends to strengthen the suggestion of the skull as to the anuran nature of the species. The vertebral column is, however, quite long; entirely too long for the frogs as we know them. The writer has in mind some embryological investigations which ought to go a long way toward settling this question, and he hopes to present a discussion of his results elsewhere. If *Pelion lyelli* Wyman is not related to the early ancestors of the frogs then we have not the slightest evidence of frogs or frog-like animals prior to the Eocene. The form named by Marsh *Eobatrachus agilis* from the Lower Cretaceous of Wyoming is too incomplete and too insufficiently described to afford definite information as to what it is.

Among several specimens of Carboniferous quadrupeds received by Professor Cope for study from Mr. R. D. Lacoe, of Pittston, Pa., was a specimen of the earliest known reptile, which was in 1896 first placed by Cope in the species *Tuditanus punctulatus* Cope. Later (1897), however, he removed the form to another genus, *Isodectes*, but retained the same specific term for the form.

Recently, Williston (Journ. Geol., July–August, 1908) has redescribed the specimen and has referred it to another species, which he calls *Isodectes copei* sp. nov. Cope distinctly stated in 1896, and again in 1897, that the form was a true reptile, and as such was the earliest reptile known. His statement seems, however, to have been overlooked, for when Raymond announced the discovery of Carboniferous vertebrates near Pittsburg, Pa., he stated that the forms there discovered were the oldest known reptiles; but Cope's discovery antedated his in two ways—chronologically and geologically. Holland corrected this error in the report of the director of the Carnegie Museum for 1908.

The specimen as preserved is less than six inches long and consists of the entire body of the animal, minus the head and the right fore limb. The absence of the head is to be especially regretted, for it is upon the skull characters that most of our classification is based, and it is to this portion of an animal's anatomy that we refer for the final analysis of the creature's position. The most noteworthy reptilian characters which can be detected on the remains preserved to us are the osseous carpus and tarsus, two sacral vertebræ, the reptilian phalangeal formula (2, 3, 4, 5, 4) for the hind foot, the inter-central attachment of the ribs (as is the case in the Microsauria), and the well ossified condition of the limb bones, a matter of no slight importance. In some of its characters it is so close to the Microsauria that were it not for the two sacral vertebræ and the osseous carpus and tarsus it would undoubtedly find a place among the Amphibia. The absence of ventral ribs is to be especially noted.

The presence or absence of the ventral ribs seems to be a matter which is little understood, and doubt has been thrown on the use of this character as one of any importance. Among the Microsauria there are forms which possesss well-developed ventral ribs, and others, not distantly removed otherwise in structure, which possess no ventral ribs whatever, *i. e.*, the Tuditanidæ and the Amphibamidæ. What the function of the ventral ribs was is also a little doubtful. To say that they developed merely to protect the abdomen of the animal is merely begging the question, for if they develop for this purpose in one form why should not other forms with similar habits also develop similar structures? The degree of the ossification of the limb bones is a matter to which but slight attention has been paid. In the study of a large series of the Microsauria this is found to be quite variable. Some forms seem to have the limb bones made up of perichondrium alone,

while others exhibit highly developed endochondrium, and this occurs in forms which we place in the same genus—for instance *Tuditanus punctulatus* Cope and *Tuditanus minimus* Moodie. Just what this may mean remains to be determined. It is possible that it is due to the mode of preservation.

Another form of the greatest interest is the one recently described by the writer from the Mazon Creek beds of Illinois as *Micrerpeton caudatum.* This interesting little fossil is less than two inches in length, but there are preserved in its matrix more characters than we would expect in many specimens of fossil amphibians. The form represents the only species of Branchiosauria so far discovered in North America. On the small nodule in which *Micrerpeton* is embedded there are found a nearly complete outline of the body; a nearly complete skeleton; the black pigment of the eyes; the pigment of skin and the pattern it assumed; minute scales which covered the body; the lateral line canals of the tail, and the ventral scutes—enough, in fact, to warrant a restoration of the animal, and this has been given. (Plate II, fig. 1.)

Another form which will interest us here is the one described in 1865 by Cope under the name of *Amphibamus grandiceps.* This form is known from nearly complete remains which have been described by Dr. O. P. Hay, and again described by the writer with a restoration. The form is interesting as being a typical member of the Microsauria. (Plate III.) It had a short, stumpy tail, a short body, and a short, broad head It had four toes on the hand and five on the foot, with the phalangeal formula of 2, 2, 3, 2 for the hand and of 2, 2, 3, 4, 3 for the foot. The skeleton of the animal has been restored, with an outline of the body.

Still another form is the one described by Cope as *Molgophis macrurus*, which had neither limbs, ribs nor ventral armature, but consisted merely of a very elongate vertebral column consisting of nearly 100 minute vertebræ and a sharp-pointed skull. This form resembles in great degree the modern whipsnake of Kansas in form and proportions, though it was scarcely ten inches in length.

I have described for you now five forms, which we will try to discuss in the light of our present knowledge in regard to their classification. The first form, *Pelion lyelli* Wyman, is an aberrant form and may be related to the frogs. It has been placed in the Branchiosauria and in the Microsauria. It belongs in neither, but may be placed provisionally in the latter group. The form *Isodectes copei* Williston has been shown to be a true reptile, and we

need only to say here that its structure is so close to that of some of the Microsauria that the resemblance must be of genetic importance. The *Micrerpeton caudatum* has been proved elsewhere to belong among the Branchiosauria, and this group has been shown to be true amphibians, as we know them to-day. The *Amphibamus* is a true microsaurian, and the *Molgophis* is a side branch of the microsaurians which is known as the *Aistopoda.* Whether the group is entitled to a distinct ordinal rank is open to question. On the basis, then, of the foregoing discussion, we will here propose the following classification for the class Amphibia:

Class AMPHIBIA. Linné, 1758. Devonian to recent.
- Subclass I. Euamphibia nom. nov. Carboniferous to recent.
  - Order 1. Branchiosauria. Credner. Carboniferous.
  - Order 2. Apoda (Gymnophiona). Muller, 1832. Permian(?) to recent.
  - Order 3. Caudata. Dumeril, 1806. Permian(?) to recent.
  - Order 4. Salientia (Anura). Laurenti, 1768. Eocene to recent.
- Subclass II. Holospondyli. Schwarz, 1908. Carboniferous and Permian.
  - Order 1. Microsauria. Dawson, 1863. Carboniferous.
  - Order 2. Aistopoda. Miall, 1874. Carboniferous.
  - Order 3. (?) Diplocaulia nom. nov. Permian.
- Subclass III. Stegocephala. Cope, 1868. Carboniferous to Upper Triassic (Jurassic?).
  - Order 1. Temnospondylia. Zittel, 1887.
    - Suborder 1. Rhachitomi. Cope.
    - Suborder 2. Embolomeri. Cope.
  - Order 2. Stereospondylia. Zittel, 1887. Carboniferous to Triassic.

NOTE.—It is doubtful whether the new order, Diplocaulia, belongs in subclass II or subclass III. This will be definitely settled when Williston's results have been made fully known. Full definitions of these new groups will be given in the Kansas University *Science Bulletin* for 1909.

EXPLANATION OF PLATES.

PLATE I.

Photograph of the specimen of *Pelion lyelli* Wyman. This form may be a true ancestor of the modern frogs or it may be an aberrant member of the Microsauria. Times, 1½.

PLATE II.

FIG. 1. *Micrerpeton caudatum* Moodie; a branchiosaurian from the Carboniferous of Illinois.

FIG. 2. *Isodectes copei* Williston; a true reptile from the Carboniferous of Ohio.

FIG. 3. *Tuditanus minimus* Moodie; a microsaurian from the Carboniferous of Pennsylvania.

FIG. 4. *Ptyonius nummifer* Cope; one of the atypical members of the Aistopoda which serve to connect the Aistopoda with the Microsauria. No limbs are present in this form. Carboniferous of Ohio.

FIG. 5. *Tuditanus brevirostris* Cope; a microsaurian from the Carboniferous of Ohio.

PLATE III.

Amphibamus grandiceps Cope; a true microsaurian from the Mazon Creek beds of Illinois. The outline of the body is well exhibited.

PLATE I. Carboniferous fossils.

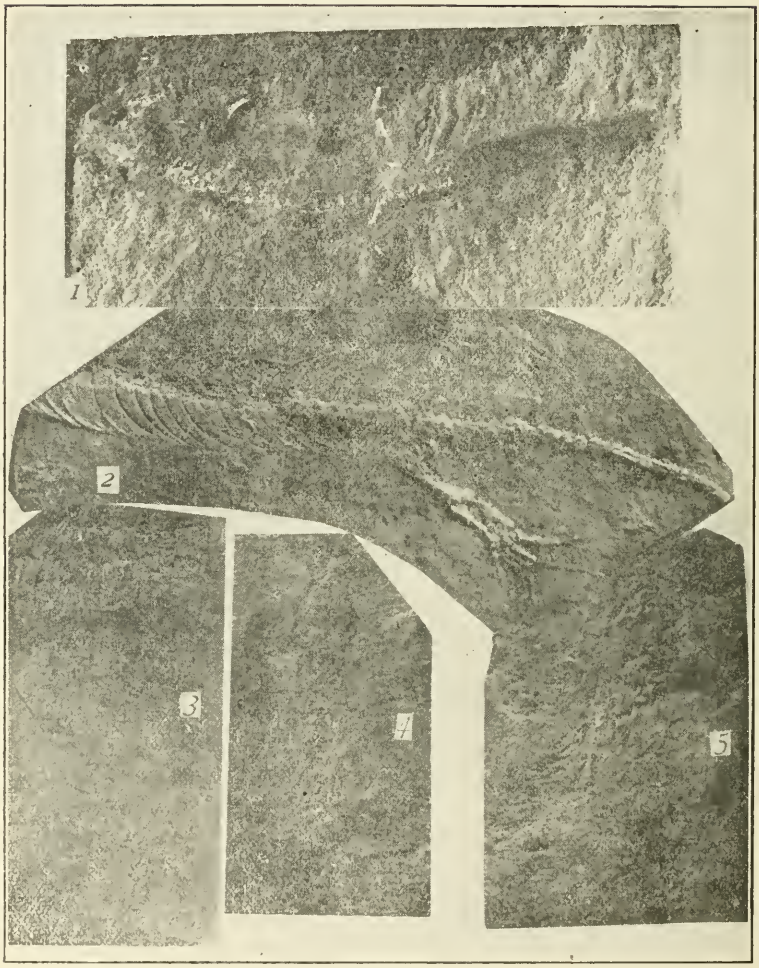


PLATE II. Carboniferous fossils.

PLATE III. Carboniferous fossils.

FORMATIONS OF THE MARION STAGE OF THE KANSAS PERMIAN.[1]

By J. W. BEEDE, of Indiana University, Bloomington, Ind.

THE formations of the lower white Permian of Kansas have been well understood for some time. The upper part, largely on account of its poor exposures and relatively weak escarpments, has not heretofore been carefully worked out. The field-work of the Kansas and Oklahoma surveys during the past summer has thrown some light upon the importance and extent of these rocks.

The formations here considered lie above the disputed beds of the Meek, Swallow and others. They lie on the back slope of the Flint Hills and form a relatively fertile plain of little relief, which is in striking contrast to the rough topography of the Flint Hills to the eastward. The region studied lies in Dickinson, Geary, Morris and Marion counties of Kansas, and Kay and Noble counties of Oklahoma. Some of the formations may reach to the Nebraska line, though if they do they are quite thinned and changed in appearance. The maps represent field-work done in two localities near Marion, the type locality of the Marion stage, and the vicinity of Herington and north to the Smoky Hill river. The region about Marion and the immediate vicinity of Herington is my own mapping, and that lying north of Woodbine is the work of the Rev. John Bennett, the veteran stratigrapher of Kansas.

The rocks of the section were early described in a general way by Meek and Hayden, who traversed the region in two directions. Their section of the rocks of the Marion formation, as given in the general section of the region, is given below, the rocks numbered from the top down. We begin with No. 5, the first one coming within our region:

5. Bluish, red, light-yellow and gray clays, and soft claystones, with sometimes a few thin layers of magnesian limestone. In many places these clays have been traversed in every direction by cracks, into which calcareous and argillaceous matter have found their way, and subsequently became consolidated so as to form thin seams of yellowish impure limestone, which cross and intersect each other at every angle. The red clays are usually less distinctly laminated, contain more arenaceous matter, and often show ripple-marks on the surfaces. *Locality, bluffs along Smoky Hill river above the mouth of the Grand Saline*..... .... 60 feet.

1. By permission of the State Geologists of Kansas and Oklahoma.

6. Light-gray, ash-colored and red clays, sometimes arenaceous, and often traversed by cracks filled with calcareous matter as in the bed above—alternating with thin layers and seams of gypsum. *Locality, near the mouth of the Smoky Hill [Solomon] river* ..... 40 feet.
7. Rather compact amorphous white gypsum, with near the base disseminated crystals, dark colored, do. *Locality, same as last* ..... 4½ to 5 ft.
8. Alternations of ash-colored, more or less arenacous clays, with thin beds and seams of gypsum above; towards the lower part, thin layers of claystone, and at some places soft magnesian limestone. *Locality, same as last*..... 50 feet.
9. Rough conglomerated mass, composed of fragments of magnesian limestone and sandstone, with sometimes a few quartz pebbles, cemented by calcareous and arenaceous matter; variable in thickness and probably local. *Locality, south side of Smoky Hill river, ten or twelve miles below Solomon's Fork* ..... seen, 18 feet.
10. Bluish, light-gray and red laminated clays, with seams and beds of yellow magnesian limestone, containing *Monotis hawni, Myalina perattenuata, Pleurophorus? subcuneata, Edmondia? calhouni, Pecten* undet., and *Spirigera* near *S. subtilita;* also *Nautilus eccentricus, Bakewellia parva, Leda subscitula, Axinus rotundatus,* and undetermined species of *Bellerophon, Murchisonia,* etc. *Locality, near Smoky Hill river, on high country south of Fort Riley, as well as on Cottonwood creek,* 90 feet.
11. Light-grayish and yellow magnesian limestone in layers and beds, sometimes alternating with bluish and other colored clays, and containing *Solemya,* a *Myalina* near *M. squamosa, Pleurophorus? subcuneata, Bakewellia parva, Pecten* undet., and a *Euomphalus* near *E. rugosus;* also a *Spirigera* allied to *S. subtilita,* but more gibbous, *Orthisina umbulacrum?, O. shumardana,* etc. *Locality, summit of the hills, near Fort Riley and above there; also seen on Cottonwood creek*... 25 to 35 feet.
12. Light-grayish yellow, rather granular magnesian limestone, containing spines and plates of *Archæocidaris;* a few fragments of small crinoid columns, *Spirifer,* similar to *S. lineatus,* but perhaps distinct; also same *Spirigera* seen in the beds above, *Orthisina shumardana, O. umbulacrum?* and *Productus calhounianus. Forms distinct horizon near summit of hills in vicinity of Fort Riley; also seen on Cottonwood creek*..... 7 to 8 feet.
13. Soft argillo-calcareous bed, apparently local. *Kansas Flaas*.. 5 feet.
14. Light grayish yellow magnesian limestone, containing many concretions of flint; also the same *Spirigera* found in the rocks above, *Productus norwoodi, P. calhounianus* with *Discina tenuilineata,* and an undetermined *Monotis. Fort Riley and below; also at Kansas Falls and on Cottonwood creek*... 38 feet.

This section, with the article from which it was taken, was published in the Proceedings of the Philadelphia Academy of Sciences, 1859, pp. 16, 17.

It is by no means a simple matter to correlate Meek and Hayden's section with our present knowledge of the section of this region. No. 22 of their section is pretty certainly the Cottonwood limestone. If this is the case, No. 18 would probably represent the Wreford limestone, and 16 may be the "main ledge" of the Fort Riley limestone. If this is true, then 15 would be the Doyle shales and 14 the Winfield limestone. This would make the upper part of the section correspond in a rough way to the Marion-Herington section which is to follow. The conglomerate No. 9 (Prosser's Abilene conglomerate) probably represents the layer referred to that name and horizon below occurring near Herington and Marion, though there are some lithologic differences in its make-up. This would leave 10 and 11 to represent the remainder of the rocks to the Luta limestone, No. 12. The general condition of the region, with sections, is given by Prosser.[2] Owing to the possible occurrence of low dome-like structures in the Permian rocks of this region we cannot correlate the sections near Salina and the Gypsum creek region with the eastern section until our detailed studies are carried over it.

In 1895 Prosser published the "Classification of the Upper Palaeozoic Rocks of Central Kansas."[3] In this paper he divided the Permian rocks into "formations or stages." The formations of the Chase stage are now familiar to those acquainted with the stratigraphy of the region and will be omitted. The Marion was subdivided as follows:

PERMIAN.-	MARION. (Prosser).	Variously colored shales and marls. Colored shales and marls alternating with beds of gypsum. Buff limestones and marls.
		Abilene conglomerate.
		Buff limestones which contain large *Lamellibranchia.*
		Grayish (?) limestones containing plenty of *Bakewellias,* near this horizon in some localities a concretionary limestone. Thin buff limestone with a few *Derbyas.*
	CHASE.	

2. Univ. Geol. Surv. Kan., II, pp. 56-64, 1897.
3. Jour. Geol., III, pp. 682-705, 764-800.

The portion of the tabulation containing the faunal characteristics and general thicknesses is here omitted.

In a tabulated section of the Kansas Permian rocks published later[4] he did not differentiate the Marion formation, and let it, with the Wellington shales of Cragin, go to make up the Sumner stage of this author. I am in part at least responsible for this classification, and at the time doubted the advisability of subdividing the Marion. Much additional study has convinced me of the advisability of subdividing it, not to say the necessity of it. The Marion will have to go back to its original rank of a stage. The further discussion of the classification of the section into stages and larger groupings must await the working out of the paleontology of the beds.

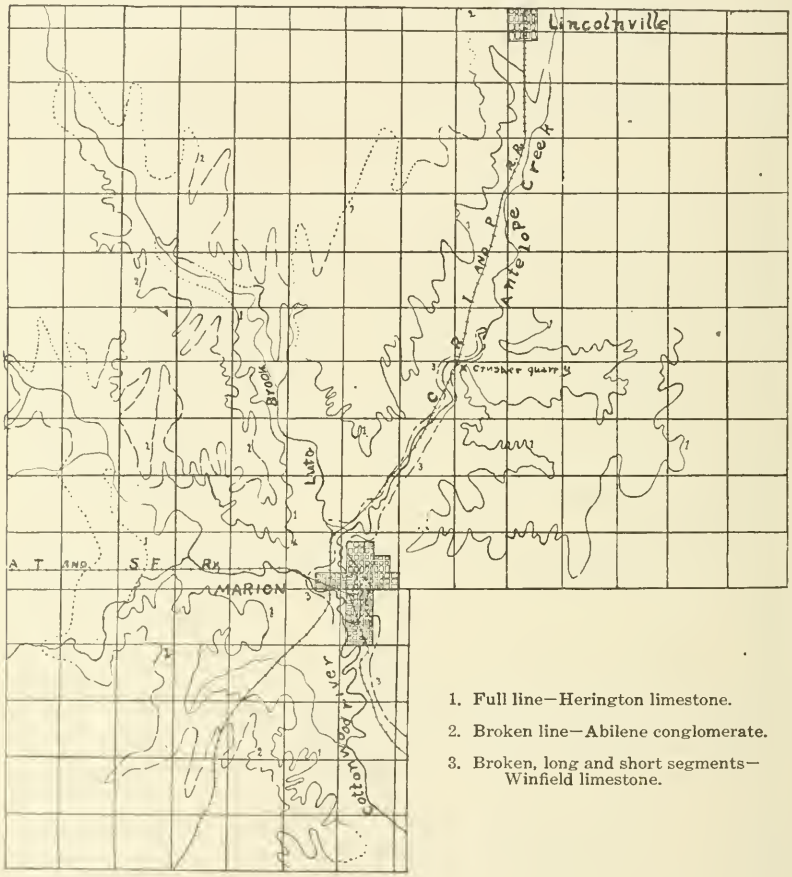
THE SECTION.

In order to give an idea of the section as a whole and the relation of the Marion stage to that of the Chase, the formations of the latter are enumerated from below upward: Wreford limestone, Matfield shales or formation, Florence flint, Fort Riley limestone, Doyle shales, and Winfield limestone. The first, third and fifth of these formations carry very large amounts of chert, which give rise to the term "Flint Hills" for the rugged country of their outcrop. The outcrop of the Marion rocks does not produce a rugged topography and the flint is nearly absent. The faunal distinctions between the two stages is quite as sharp as is the lithological or physiographical differences.

The Luta limestone.—Over a very considerable portion of central Kansas the Luta limestone forms the basal member of the Marion stage. It is well exposed in the city of Marion on Main street, east of the bridge, by the church. The limestone at the spring in the park is probably the Winfield. The Luta limestone as a whole is a more or less cellular, soft, gray stone thirty feet in thickness, with siliceous and other geodes scattered through it, and layers of more or less abundant chert concretions. The type exposure is taken at the crusher quarry about five miles northeast of Marion, on the Chicago, Rock Island & Pacific railroad. Here the total thickness is exposed, together with the top of the Winfield limestone. This section is given below. From observations at Arkansas City it seems that this limestone is very thin if it is not wanting there, and it is absent from the section east of Newkirk, Okla. It is exposed in a quarry along the railroad just north of Herington, and seems to be but ten or fifteen feet thick. It is

4. Prosser, Revised Classification of the Upper Paleozoic Rocks of Kansas, Jour. Geol., X, p. 718, 1902.

either wanting or very thin in Washington and Marshall counties in northern Kansas. It seems that it is thickest at Marion, thinning to the north and south. Nevertheless, it is present over a very considerable part of central Kansas region. It is so soft that it is of little value except for ballast. Its name is derived from Luta brook, which enters into Antelope creek just north of the city limits of Marion.



The following is the section at the crusher quarry, five miles northeast of Marion:

	Feet.	Inches.
7. Basal part of the Herington limestone	+	...
6. Yellow shales	15	0
5. Soft limestone, persistent	0	8
4. Green and yellowish shales	7	0

	Feet.	Inches.
3. Maroon shales	13	0
2. Limestone in thicker and thinner layers, some flaggy, cellular, geodiferous, and containing some bands of chert concretions	30	0
1. Winfield limestone(?) top layer, full of fine chert concretions (only upper part of layer shown)	4	0

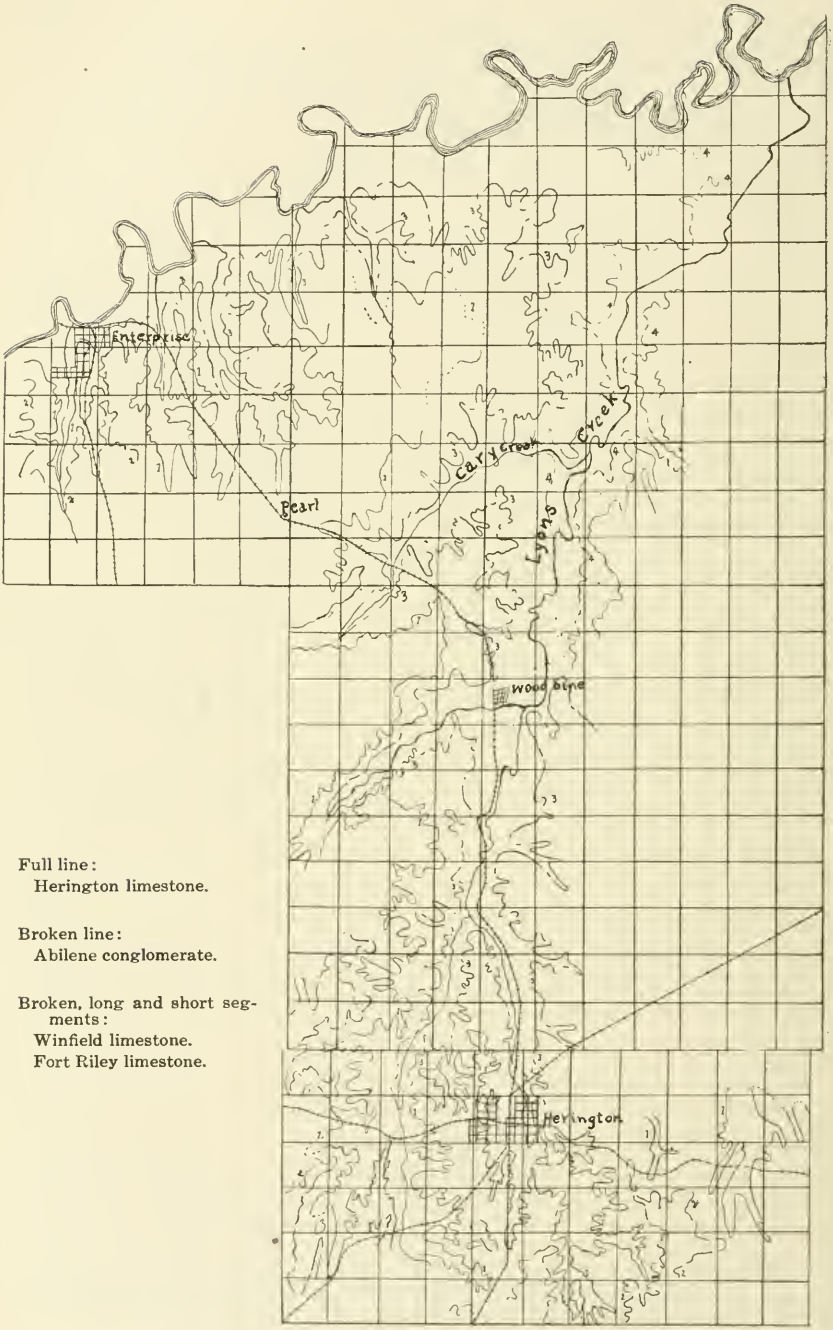
In this section No. 2 is the Luta limestone. Nos. 3 to 6 are the Enterprise shales, and No. 7 is the base of the Herington limestone.

Enterprise shales.—Over the Luta limestone are the Enterprise shales, shown in position about the town of Enterprise. The exposure in the section just given is the only one that I have seen showing the whole thickness in the central part of the state. They have been noted as far south as the vicinity of Uncas, in Kay county, Oklahoma, and are remarkably persistent and constant in their thickness. As will be seen from the section at the McCarty place, thin limestones occasionally come in near the top. These shales reach their maximum thickness, so far as now known, at Arkansas City, where there are forty-four feet of them.[5]

Herington limestone.—Though not very thick, the limestone is very extensive south of the Kansas river. It forms the elevations in the eastern and western parts of Herington. It is quarried northeast, west and southwest of Marion and at other places. It is known to occur at Enterprise, Herington, Marion, and without doubt is continuous with the limestone occupying the same horizon from west of Winfield through Arkansas City to Kay and Noble counties, Oklahoma. Its texture varies somewhat from place to place, even within very limited areas. In the bottoms of small valleys certain soft, geodiferous flaggy layers are sometimes found which are usually eroded away on escarpments, the softer material apparently resting upon the more resistant. The persistent layers are harder, of more of a buff shade, more massive, and very fossiliferous. Sometimes these fossils are very small species of pelecypods and occasionally they are rather large, perhaps occupying separate layers. This limestone, in all probability, is exposed in the top of the bluff north of Arkansas City (foot-note, *ante*), where it is about fifteen feet thick. It was correctly referred to the Marion by Prosser.[6] As we proceed southward the texture of this rock becomes coarser. This is especially noticeable in its exposure two or three

5. Stratigraphy of the Eastern Outcrop of the Kansas Permian, Amer. Geol. XXXVI, p. 108, 1905.

6. K. U. Quart. VI, pp. 173-175, 1897. Doubt of this reference was expressed by Beede in the paper on "Stratigraphy of the Eastern Outcrop of the Kansas Permian," mentioned previously. The correctness of Prosser's reference was verified by Mr. Hooper under my direction.



Full line:
Herington limestone.

Broken line:
Abilene conglomerate.

Broken, long and short segments:
Winfield limestone.
Fort Riley limestone.

miles east of Newkirk, Okla., where both this and the underlying Winfield limestone become arenaceous in their eastern edges. All these limestones, from the Wreford up, grade into the Red Beds, in about the latitude of Perry, Okla.

Section of the Herington limestone and the top of the Enterprise shale at the McCarty place, two miles northwest of Marion, Kan.:

	Feet.	*Inches.*
6. Limestones, thicker and thinner, buff, fossiliferous, and not very hard. Lower ones soft and massive, others somewhat porous and geodiferous. Near the top is a two-foot layer with myriads of small pelecypods; over this is another layer with larger shells	9	0
5. Shales, drab, weathering yellowish	11	3
4. Soft limestone, weathering shaly	1	0
3. Marly shales.....six inches to	0	8
2. Thin bedded, soft limestone	2	0
1. Olive clayey, perhaps calcareous shales	0	6

No. 6 of this section is the Herington limestone. The exposures in the creeks two miles north and three miles west of Marion are probably above this outcrop, as no bottom to them could be seen, and the texture, as mentioned above was different. The total thickness near Marion may reach twelve or fifteen feet.

Pearl shales.—These shales are probably included in No. 10 of Meek and Hayden's section given above, as, perhaps, is the Herington limestone too. On account of the weakness of the overlying formation and its consequent recession from the outcrop of the limestone below the exposures of this formation are few and small and do not show the nature of its entire thickness at any one place. It is known to be a succession of red, blue and green ones, though the dimensions of the individual layers are unknown. The estimated thickness of the Pearl shales in the vicinity of Herington and Marion is seventy feet.

The upper part of this shale is of the character of the "cracked" shales described by Meek and Hayden in their section already referred to. This structure continues up to the "conglomerate" at the top of the formation in such a way as to make it difficult to distinguish them in the region northwest of Marion, where there are no good exposures. Below this material are blue, red and drab shales in variable thickness to the limestone below. The term "Pearl shales" is used because that station on the Rock Island railroad is in the vicinity of their outcrop.

Abilene conglomerate.—The stratum to which this term is applied has not been correlated with certainty with the Abilene conglomerate, and the appellation is provisional until positive cor-

relation is made. However, while the texture of the stone varies somewhat from that of the original exposure, its distance from the base of the Marion is about the same and its nature is not all inconsistent with such a correlation. The conglomerate was first described by Meek and Hayden in No. 9 of the section quoted above. The name, "Abilene conglomerate," was first applied as a formation name by Prosser in "The Classification of the Upper Palæozoic Rocks of Kansas."[7] It is a calcareous conglomerate, containing some sand and sandstone pebbles, near Abilene, where it seems to be considerably thicker than in the Herington-Marion region. In the field, no sand or sandstone was noted in the rock about Herington or Marion. It is a heavy, hard, perhaps dolomitic stone, composed of fragments of yellow, orange and gray masses firmly united in a light-gray cementing material. As previously noted, it rests upon the "cracked shale," which is rather thick in places and frequently not very dissimilar in appearance in poor exposures. It forms a weak escarpment which has been followed as far south as the divide between Marion and Peabody. Certain peculiar calcareous deposits south of Doyle creek near Peabody probably belong in the same horizon. It has not yet been recognized in Oklahoma.

This is the highest stratum of rocks in the Kansas white Permian making an escarpment of sufficient strength and continuity to be mapped over large areas. Above this horizon the limestones and gypsums appear to be more or less lenticular and discontinuous, so far as our investigations have gone. More detailed work may show that series of these occupy the same stratigraphic horizons and admit of approximate mapping, but it hardly seems so at present. In this respect the rocks of the Marion stage are quite distinct from those of the Wellington shales. So far as known, too, the Wellington shales are fossiliferous only in few localities and probably fewer horizons. For these reasons it seems best to limit the Marion stage to the formations herein described and shown on the accompanying maps, where only the limestones are shown.

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7. Jour. Geol, III, p. 797, 1895.

AN ARMORED DINOSAUR FROM THE KANSAS CHALK.

By Charles H. Sternberg, Lawrence.

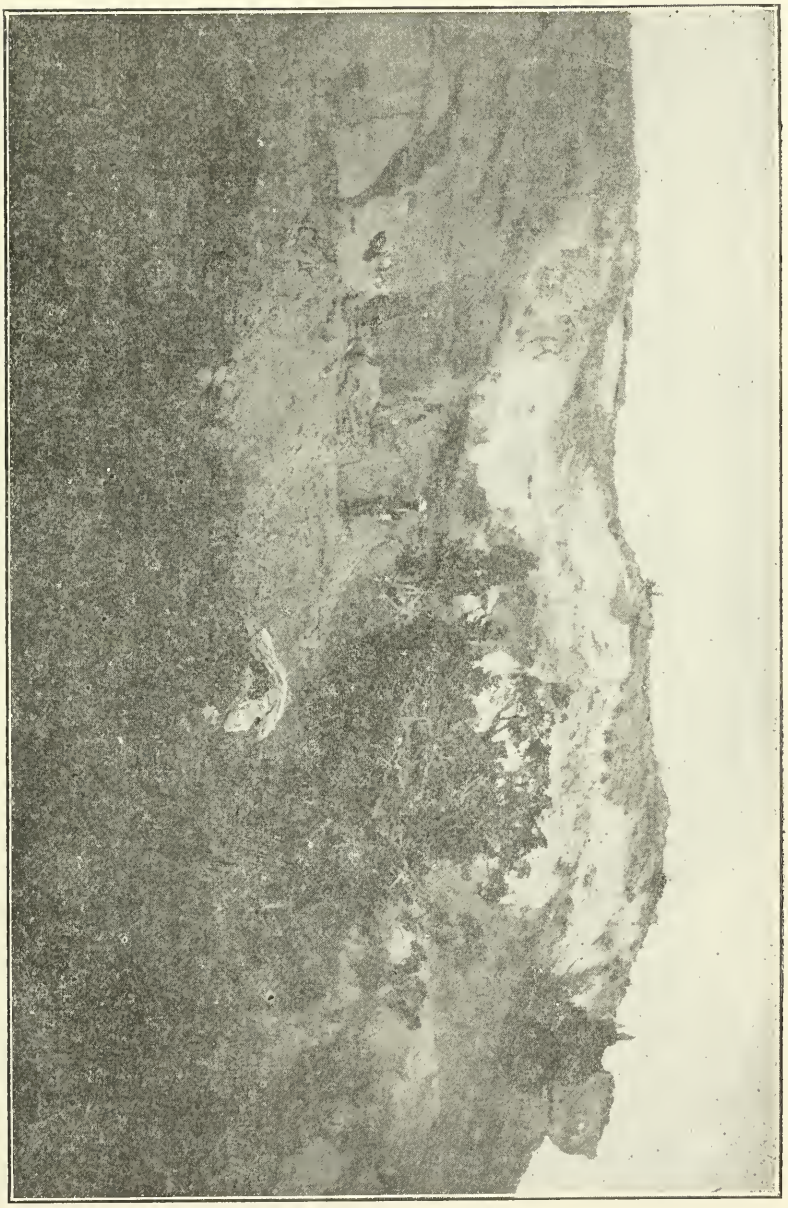
LAST February Barnum Brown, of the American Museum of Natural History staff, published a description for the first time of his wonderful armored dinosaur, which he named *Anchylosaurus magniventris*, representing a new family, genus, and species. It was discovered in 1906 by the American Museum expedition in "The Hell Creek Beds of Montana." It represents, he says, a group of *Stegosauria*, characteristic of the late Cretaceous of this country.

The skull is entirely covered with plates, which are coösified in continuous surface, and cover top and sides of the head. Some thirty dermal plates were discovered, and in their restoration they and others are arranged in parallel rows along the entire back and sides of the reptile. They are diamond-shaped, with the sharp angles rounded off, while the center is thickened into an elevated wedge-shaped crest. In his restoration the interspaces were left naked, as he evidently had none of the connecting smaller and various shaped bodies to completely fill all the interspaces.

In 1905, while conducting an expedition in the Kansas Chalk, I discovered the broken-up skeleton of what I considered a large new sea-tortoise with an ossified carapace. It attracted my attention, and I knew it was new, but as it was weathered and detached from its matrix I concluded it could not be used and left it there. Later, my son George brought into camp, a few miles from Hackberry creek, where I had found my specimen, some peculiar plates like the ones I have already mentioned; but as I had no knowledge of Barnum Brown's discovery, I concluded they were the neurals of a new turtle.

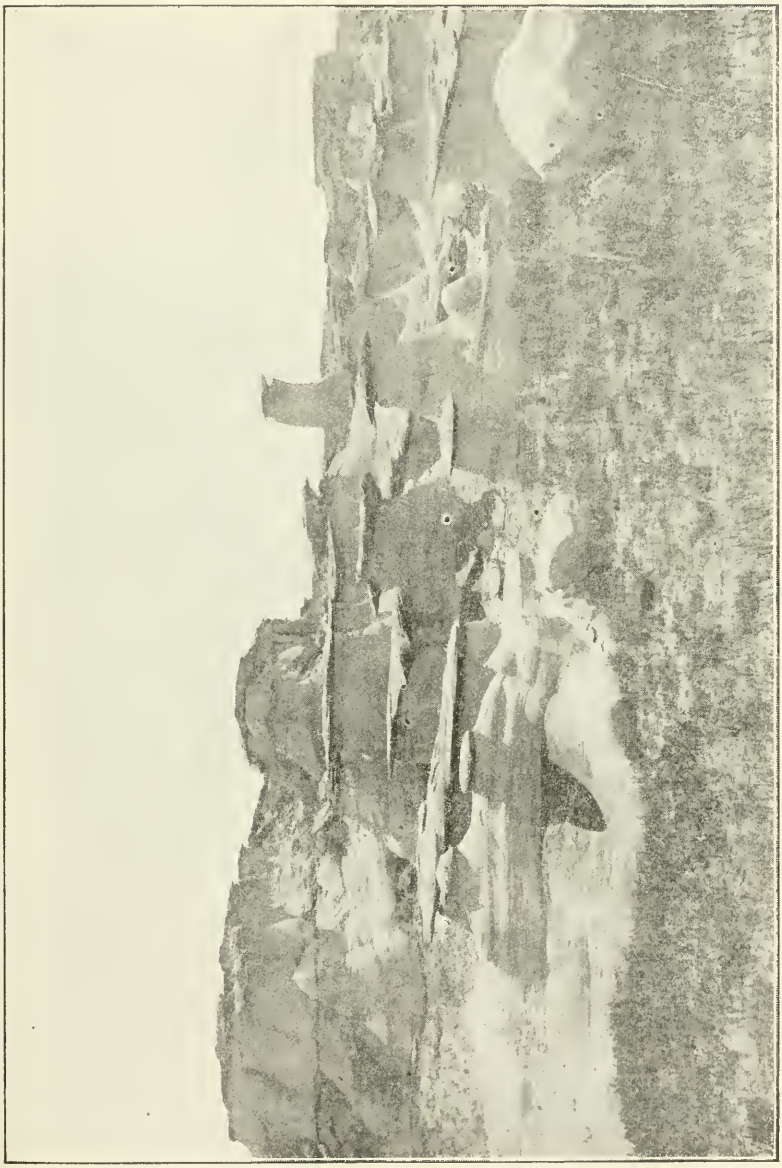
These I sent on to Dr. G. R. Weiland for description. Last month I was his guest at Yale University museum. He asked me why I thought it a new turtle. After giving my reasons, he told me it was new enough, but these plates were the dermal scutes of an armored dinosaur. Later I secured the skeleton, through the efforts of my son, who found them as I directed. I went over the mass of fragments, and separated the armor, and found that the entire skeleton was covered with a completely coössified dermal covering, in most beautiful patterns, the larger scutes being dia-

mond-shaped with rounded angles and the interspaces filled with quite small plates of various forms to completely fill them. I shall await with great interest Doctor Weiland's paper describing this remarkable dinosaur, and I am glad that another land dinosaur was carried into the Cretaceous Ocean of Western Kansas. The other one was found about forty years ago, and described by the late Professor Marsh as a form of *Hadrasaurus*, or like the duck-bill my party found last season in Wyoming, in the Laramie Beds of Converse county. Strange, indeed, then, that we find enough of a dinosaur, separated by some 10,000 feet of strata, millions of years of time and a thousand miles of space, and that way down in the Kansas Chalk; and lying stranded on a knoll of chalk, exposed to the disintegrating influences of the weather, is the specimen that will enable (in connection with the Barnum Brown specimen) science to correctly restore one of the rare ancient inhabitants of our continent.



Trachadon quarry, Wyoming.

Rock sculpturing, Converse county, Wyoming.



Mushroom rocks, Converse county, Wyoming.

IV.

BIOLOGICAL PAPERS.

1. "COCCIDÆ OF KANSAS."
   By GEO. A. DEAN, Kansas State Agricultural College, Manhattan.
2. "ADDITONAL RESULTS OF COLLECTING INSECTS IN KANSAS AND COLORADO."
   By E. S. TUCKER, United States Department of Agriculture, Washington, D. C.
3. "NOTES UPON VARIATION OF MELISSODES LUPINA CRESSON."
   By T. D. A. COCKERELL.
4. "SUPPLEMENTARY ADDITIONS TO THE LIST OF KANSAS DIPTERA."
   By E. S. TUCKER, United States Department of Agriculture, Washington, D. C.
5. "SUPPLEMENTARY ADDITIONS TO THE LIST OF KANSAS HYMENOPTERA."
   By E. S. TUCKER, United States Department of Agriculture, Washington, D. C.
6. "A NEW BIRD FOR THE KANSAS LIST, TAKEN AT LAWRENCE."
   By L. L. DYCHE, University of Kansas, Lawrence.
7. "THE POISON-GLANDS OF A RATTLESNAKE DURING THE PERIOD OF HIBERNATION."
   By L. L. DYCHE, University of Kansas, Lawrence.
8. "HABITS OF PARASITIC HYMENOPTERA, II."
   By CHARLES H. WITHINGTON, University of Kansas, Lawrence.
9. "WINTER CONDITIONS OF LENTICELS."
   By LESLIE A. KENOYER, Independence.
10. "PRELIMINARY LIST OF INSECT TYPES AND CO-TYPES IN THE FRANCIS HUNTINGTON SNOW ENTOMOLOGICAL COLLECTION."
    By CHARLES H. WITHINGTON, University of Kansas, Lawrence.
11. "NOTES ON KANSAS MAMMALS."
    By D. E. LANTZ, Biological Survey, Washington, D. C.
12. "THE GERM-PLASM HYPOTHESIS OF WEISSMANN UNTENABLE."
    By L. C. WOOSTER, State Normal School, Emporia.
13. "ADDITIONS TO THE LIST OF KANSAS COLEOPTERA FOR 1908."
    By W. KNAUS, McPherson.

COCCIDAE OF KANSAS.

By Geo. A. Dean, Assistant Professor of Entomology, Kansas State Agricultural College, Manhattan, Kan.

THE following article is a short bibliography of the Kansas Coccidæ, with the locality and the plants upon which they were taken. Mrs. M. E. Fernald's "Catalogue of the Coccidæ of the World" has been followed with reference to nomenclature. Unless otherwise stated the insects have been collected and determined by the author.

97. *Orthezia graminis* Tins.

Orthezia graminis Tins., Can. Ent., XXXI, p. 13 (1898).

Habitat: Taken on goldenrod, Blue Rapids, Marshall county. Mrs. S. G. Cady, collector. Determined by Prof. S. J. Hunter.

197. *Lecaniodiaspis celtidis* Ckll.

Lecaniodiaspis (Presopophora) celtidis Ckll., Psyche, VII, Supl., I, p, 19 (1897).
Lecaniodiaspis celtidis Ckll., The Entom., XXX, p. 12 (1897).

Habitat: Osborne. Taken on trunk of *Celtis occidentalis*. Prof. E. A. Popenoe.

204. *Lecaniodiaspis pruinosa* Hunter.

Lecaniodiaspis celtidis subsp. pruinosus Hunter, Kan. Univ. Quart., VIII, p. 77 (1899).
Lecaniodiaspis pruinosa Ckll., in litt. (1902).

Habitat: Lawrence. On elm. Professor Hunter.

226. *Solenococcus parrotti* (Hunter).

Lecaniodiaspis parrotti Hunter, Kan. Univ. Quart., VIII, p. 76 (1899).
Solenococcus parrotti Ckll., in litt. (1901).

Habitat: Lawrence. On *Æsculus glabra*. Taken by Professor Parrott.

240. *Kermes concinnulus* Ckll.

Kermes concinnulus Ckll., Can. Ent., XXX, p. 172 (1890).
" " " Psyche, IX, p. 44 (1900).

Habitat: On oak (*Quercus macrocarpa*), Manhattan.

242. *Kermes galliformis* Riley.

Kermes galliformis Riley, Am. Nat., XV, p. 482 (1881).
" " Comst., Rep. U. S. Dep. Ag., 1880, p. 337 (1881).
" " Pack., 5th Rep. U. S. Ent. Com., p. 100 (1890).
" " Lint, 12th Rep. Ins. N. Y., p. 316 (1897).
" " King, Can. Ent., XXXI, p. 139 (1899).
" " Ckll., Psyche, IX, p. 44 (1900).

Habitat: Eastern Kansas. On oaks.

251. *Kermes nivalis* King & Ckll.

Kermes nivalis Ckll., Can. Ent., XXXI, p. 139 (1899).
" " King, Psyche, LV, pp. 78, 80 (1900).
" " Hunter, Studies Ins. Life, p. 187 (1902).

Habitat: On White oak, Lawrence. Prof. S. J. Hunter.

255. *Kermes pubescens* Bogue.

Kermes pubescens Bogue, Can. Ent., XXX, p. 172 (1898).
" " King, Can. Ent., XXXI, p. 139 (1899).
" " Ckll., Psyche, IX, p. 44 (1900).
" " Hunter, Studies Ins. Life, p. 188 (1902).

Habitat: On twigs and leaves of oak (*Quercus macrocarpa* and *Q. prinoides*), Manhattan.

321. *Eriococcus kemptoni* Parr.

Eriococcus kemptoni Parr., Bull. 98, Kan. Exp. Sta., p. 144 (1900).

Habitat: Collected by J. D. Norton, on *Andropogan scoparius*, Manhattan, and also by R. H. Kempton on the same plant, at Dundee.

343. *Gymnococcus nativus* Parr.

Gymnococcus nativus Parr., Bull. 98, Kan. Exp. Sta., p. 143 (1900).

Habitat: Collected at the base of stems of *Sporobolus cryptandrus*, by H. B. Kempton, at Nickerson.

454. *Pseudococcus citri* (Risso). (Common Mealy-bug).

Dorthesia citri Risso, Essai, Hist. Nat. des Oranges (1813).
Dactylopius destructor Comst., Rep. U. S. Dep. Ag., 1880, p. 342 (1881).
" citri Osborn, Contr. Ia. Ag. Coll., No. 3, p. 2 (1898).
" " Gossard, Bull. 51, Fla. Exp. Sta., p. 120 (1900).
Pseudococcus citri Sanders, Cocc. Ohio, Pr. Ohio Acad. Sci., IV, Sp. Papers No. 8, p. 41 (1904).

Habitat: Taken on orange and lemon, K. S. A. C. greenhouse.

490. *Pseudococcus longispinus* (Targ.)

Coccus adonidum Riley, 3d Rep. Ins., Mo., p. 96 (1871).
Dactylopius adonidum Comst., Rep. U. S. Dep. Ag., 1880, p. 341 (1881).
" longispinus Osborn, Contr. Ia. Ag. Coll., p. 2 (1898).
" longifilis Newell, Bull. 43, Ia. Exp. Sta., p. 172 (1899).

Habitat: On greenhouse plants. Common in almost every conservatory in the state.

597. *Antonina bouteloua* Parr.

Antonina bouteloua Parr., Bull. 98, Kan. Exp. Sta., p. 138 (1900).

Habitat: Collected by H. B. Kempton at the base of stems of *Bouteloua hirsuta*, sand-hills south of Manhattan.

600. *Antonina nortoni* Parr. & Ckll.

Antonina nortoni Parr. & Ckll., Can. Ent., XXXI, p. 280 (1899).
" " " Bull. 98, Kan. Exp. Sta., p. 140 (1900).

Habitat: Collected by J. B. Norton, at the bases of stems of *Bouteloua racemosa*, on Bluemont, Manhattan.

601. *Antonina parrotti* Ckll.

Antonina graminis Parr., Bull. 98, Kan. Exp. Sta., p. 140 (1900).
" parrotti Ckll., in litt. (1902).

Habitat: Collected at the base of stems of *Eragrostis trichodes*, by J. B. Norton, at St. George; upon *Bulbilis dactyloides*, south of Manhattan; upon *Eragrostis trichodes*, *E. pectinacea*, *Paspalum ciliatifolium*; on sand-hills south of Hutchinson; and upon *Eragrostis trichodes*, Nickerson, by H. B. Kempton.

666. *Pulvinaria hunteri* King.

Pulvinaria hunteri King, Can. Ent., XXXIII, p. 144 (1901).

Habitat: On maple, at Kansas City, Kan. Also taken on honey-locust, by Prof. S. J. Hunter, at Lawrence.

668. *Pulvinaria innumerabilis* (Rathvon).

Coccus innumerabilis Rath., Penn. Farm Jour., p. 256 (1854).
Lecanium acericorticis Fitch, 6th Rep. Ins. N. Y., p. 775 (1859).
" " Pack., 5th Rep. U. S. Ent. Com., p. 425 (1890).
" innumerabilis Lugger, Bull. 43, Minn. Exp. Sta., p. 223 (1895).
" " Pack., 5th Rep. U. S. Ent. Com., pp. 247, 412 (1890).
" " Murtf., Bull. 26, Div. Ent. Dep. Ag., p. 39 (1892).
" " Felt, Bull. 17, n. s., Dep. Ag., p. 22 (1898).
" " Howard, Bull. 22, n. s., Div. Ent., Dep. Ag., p. 7 (1900).

Habitat: Eastern and central Kansas. On maple, hackberry, elm, and sycamore.

681. *Pulvinaria pruni* Hunter.

Pulvinaria pruni Hunter, Kan. Univ. Quart., IX, p. 104 (1900).

Habitat: Kansas. Taken on plum, at Wichita, and determined by Prof. S. J. Hunter. Also taken on White elm.

848. *Coccus hesperidum* (Linn).

Coccus hesperidum Linn., Sys. Nat., Ed. X, I, p. 455 (1758).
Lecanium " Glover, Rep. U. S. Dep. Ag., p. 44 (1876).
" " Comst., Rep. U. S. Dep. Ag., 358 (1880).
" " Gossard, Bull. 51, Fla. Exp. Sta., p. 113 (1900).
" " Thro., Bull. 209, Corn. Univ. Exp. Sta., pp. 206, 211 (1903).

Habitat: Common greenhouse scale all over the state. On lemon, orange, oleander, ferns, cinnamon tree.

850. *Coccus longulus* (Dougl.).

Lecanium longulum Dougl., Ent. Mon. Mag., XXIV., p. 97 (1887).
" " Ckll., Tr. Am. Ent. Soc., XX, p. 50 (1893).
" " Thro., Bull 209, Corn. Univ. Exp. Sta., p. 214 (1903).
" " Green, Coc. Ceylon, pt. III, p. 221 (1904).

Habitat: On *Arbutilon*, K. S. A. C. greenhouse.

Coccus frontalis (Green).

Lecanium frontale Green, Cocc. Ceylon, pt. III; p. 192 (1904).
Habitat: On *Ficus*, K. S. A. C. greenhouse.

911. *Eulecanium armeniacum* (Craw.).

Lecanium armeniacum Craw., Re. Cal. Bd. Hort., p. 12 (1891).
" " Felt, Bull. 17, n. s., Div. Ent., U. S. Dep. Ag., p. 22. (1898).
" " Hunter, Kan. Univ. Quart., VIII, p. 71 (1899).
Eulecanium armeniacum King, Kan. Ent., XXXIV, p. 60 (1902.)

Habitat: Taken by V. L. Kellogg in 1891. On plum, Kan.

913. *Eulecanium aurantiacum* (Hunter).

Lecanium macluræ Hunter, Kan. Univ. Quart., VIII, p. 67 (1899).
" aurantiacum Hunter, Kan. Univ. Quart., IX, p. 107 (1900).

Habitat: Barber county, Kansas. On twigs of Osage orange.

916. *Eulecanium canadense* (Ckll.).

Lecanium caryæ var. canadense Ckll., Can. Ent., XXVII, p. 253 (1895).
" canadense, Ckll., Can. Ent., XXX, p. 294 (1898).
" " Hunter, Kan. Univ. Quart., VIII, p. 68 (1899).
Eulecanium canadense King, Can. Ent. XXXIII, p. 333 (1901).

Habitat: University campus, Lawrence. On elm.

921. *Eulecanium cerasifex* (Fitch).

Lecanium cerasifex Fitch, 3d Rep. Ins. N. Y., p. 368 (1856).
" " Felt, Bull. 17, n. s., Div. Ent., U. S. Dep. Ag., p. 22 (1898).
Lecanium cerasifex Lowe, 16th Rep. N. Y. Exp. Sta., p. 447 (1898).
" " Luggar, 6th Rep. Minn. Exp. Sta., p. 217 (1900).
Eulecanium cerasifex King, Can. Ent., XXXIV, p. 60 (1902).

Habitat: Kansas. Common. Abundant on plum and elm; taken on hackberry and Osage orange.

924. *Eulecanium cockerelli* (Hunter).

Lecanium cockerelli Hunter, Kan. Univ. Quart., VIII, p. 70 (1899).
" " King, Can. Ent., XXXI, p. 252 (1899).

Habitat: Lawrence. Kansas City, Kan. Abundant on upper branches of *Ulmus americanum*. Taken on peach, Kansas City, Kan., April 28, 1908, alive.

942. *Eulecanium kansasense* (Hunter).

Lecanium kansasense Hunter, Kan. Univ. Quart., VIII, p. 69 (1899).
" " King, Can. Ent., XXXIII, p. 107 (1901).
" " King, Can. Ent., XXXIV, p. 60 (1901).

Habitat: Lawrence. Kansas University campus. On *Cercis canadensis*.

993. *Saissetia hemisphærica* (Trag.).

Lecanium hemisphæricum Comst., Rep. U. S. Dep. Ag., 1880, p. 334 (1881).
" " Riley, Ins. Life, I, p. 144 (1888).
" " Coq., Bull. 26, Div. Ent. Dep. Ag., p. 27 (1892).
" coffeæ Green, Cocc. Ceylon, pt. I, p. 1 (1896).
" " Ckll., Pr. Acad. Nat. Sci. Ph., p. 270 (1899).
Saissetia hemisphærica King, Psyche, IX, p. 297 (1902).

Habitat: Kansas. Common greenhouse pest on ferns, oleanders.

998. *Saissetia oleæ* (Bern).

Chermes oleæ Bern., Mem. d'Hist. Nat. Acad., Marseille, p. 108 (1782).
Lecanium oleæ Comst., Rep. U. S. Dep. Ag., 1880, p. 336 (1881).
" " Koebele, Bull. 21, Div. Ent. Dep. Ag., p. 15 (1890).
" " Thro., Bull. 209, Corn. Univ. Exp. Sta., p. 214 (1903).

Habitat: On flowering maple and oleanders in Kansas State Agricultural College greenhouse.

1015. *Aclerda californica* (Ehrh.).

Nidularia (?) californica Ehrh., Can. Ent., XXXI, p. 103 (1899).
Pseudolecanium californicum Parr., Bull. 98, Kan. Exp. Sta., p. 145 (1900).

Habitat: At the base of the stems of *Andropogon furcatus* upon sand-hills south of Manhattan (Parrott) and near St. George (J. B. Norton).

1018. *Aclerda obscura* (Parrott).

Pseudolecanium obscurum Parr., Bull. 98, Kan. Exp. Sta., p. 144 (1900).

Habitat: At the base of the stems of *Andropogon scoparius* at Lost Springs, Parsons, Fredonia, and upon *Sporobolus longifolius*, Green Mound (Parrott).

1036. *Chionaspis americana* Johnson.

Chionaspis americana Johns., Ent. News, VII, p. 150 (1896).
" " Cooley, Spec. Bull. Mass. Exp. Sta., p. 41 (1899).
" " Hunter, Kan. Univ. Quart., IX, p. 102 (1900).
" " Sanders, Cocc. O., Pr. Ohio Acad. Sci., IV, Sp. Papers No. 8, p. 43 (1904).

Habitat: Well distributed all over the state on *Ulmus americana.*

1045. *Chionaspis corni* Cooley.

Chionaspis corni Cooley, Spec. Bull. Mass. Exp. Sta., p. 15 (1889).
" " King, Can. Ent., XXX, p. 61 (1902).
" " Sanders, Cocc. Ohio, Pr. Ohio Acad. Sci., IV, Sp. Papers No. 8, p. 45 (1904).

Habitat: Taken on willow along the Kansas river, Riley county.

1055. *Chionaspis furfura* (Fitch).

Aspidiotus furfurus Fitch, 3d Rep. Ins. N. Y., p. 352 (1856).
" cerasi Fitch, 3d Rep. Ins. N. Y., p. 368 (1856).
Chionaspis furfurus Webster, Bull. 45, Ohio Exp. Sta., p. 208 (1892).
" furfura Cooley, Spec. Bull. Mass. Exp. Sta., p. 23 (1899).
" " Forbes, 22d Rep. Ins. Ill., p. 118 (1903).
" " Sanders, Cocc. Ohio, Pr. Ohio Acad. Sci., IV, Sp. Papers No. 8, p. 47 (1904).

Habitat: On apple, Harper and Kansas City, Kan.; and on mulberry, Hutchinson.

1063. *Chionaspis longiloba* Cooley.

Chionaspis longiloba Cooley, Spec. Bull. Mass. Exp. Sta., p. 16 (1899).
" " Sanders, Cocc. Ohio, Pr. Acad. Sci., IV, Sp. Papers No. 8, p. 47 (1904).

Habitat: Taken on cottonwood along south side of campus, K. S. A. C., by C. H. Withington; taken on cottonwood, Goodland, by T. J. Headlee.

1071. *Chionaspis ortholobis* Comst.

Chionaspis ortholobis Comst., Rep. U. S. Dep. Ag., 1880, p. 317 (1881).
" " Cooley, Spec. Bull. Mass. Exp. Sta., p. 17 (1899).
" " Hunter, Kan. Univ. Quart., IX, p. 101 (1900).
" " Sanders, Cocc. Ohio, Pr. Ohio Acad. Sci., IV, Sp. Papers No. 8, p. 48 (1904).

Habitat: Taken by Parrott on cottonwood, Riley county.

1073. *Chionaspis pinifoliæ* (Fitch). (The pine-leaf scale.)

Aspidiotus pinifoliæ Fitch, 2d Rep. Ins. N. Y., p. 488 (1855).
Mytilaspis " LeBaron, 1st Rep. Ins. Ill., p. 83 (1871).
Chionaspis " Comst., Rep. U. S. Dep. Ag., 1880, p. 318 (1881).
" " Cooley, Spec. Bull. Mass. Exp. Sta. p. 30 (1899).
" " Sanders, Cocc. Ohio, Pr. Ohio Acad. Sci., IV., Sp. Papers No. 8, p. 49 (1904).

Habitat: Taken by Parrott on pine, K. S. A. C. campus; Riley county, Kansas; Blue Rapids.

1075. *Chionaspis platani* Cooley.

Chionaspis platani Cooley, Spec. Bull. Mass. Exp. Sta., p. 36 (1899).
" " Hunter, Kan. Univ. Quart., IX, p. 103 (1900).
" " Kuw., Pr. Cal. Acad. Sci. (3) III, p. 77 (1902).

Habitat: Riley county, on sycamore. Collected by Parrott. The only locality in which this species is known to occur in America is Riley county, Kansas.

1082. *Chionaspis salicis-nigræ* (Walsh.)

Aspidiotus salicis-nigræ Walsh, 1st Rep. Nox. Ins. Ill., p. 40 (1868).
Chionaspis salicis Comst., Rep. U. S. Dep. Ag., 1880, p. 320 (1881).
" salicis-nigræ Cooley, Spec. Bull. Mass. Exp. Stat., p. 19 (1899).
" " Hunter, Kan. Univ. Quart. IX, p. 101 (1900).
" " Sanders, Cocc. Ohio, Pr. Ohio Acad. Sci., IV, Sp. Papers No. 8, p. 49 (1904).

Habitat: Taken by Parrott on willows along the Blue river and on Mount Prospect, Riley county.

1096. *Diaspis boisduvalii* Sign.

Diaspis boisduvalii Sign., Ann. Soc. Fr., (4), IX, p. 432 (1869).
" " Comst., 2d Rep. Ent. Corn. Univ., p. 86 (1883).
" " Sanders, Cocc. Ohio, Pr. Ohio Acad. Sci., IV, Sp. Papers No. 8, p. 51 (1904).

Habitat: Taken on palms, K. S. A. C. greenhouse.

1103. *Diaspis echinocacti cacti* Comst.

Diaspis cacti Comst., 2d Rep. Dep. Ent. Corn. Univ., p. 91 (1883).
" " Ckll., Can. Ent., XXV, p. 127 (1894).
" " Lugger, 6th Rep. Minn. Exp. Sta., p. 235 (1900).
" echinocacti cacti Sanders, Cocc. Ohio, Pr. Ohio Acad. Sci., IV, Sp. Papers No. 8, p. 52 (1904).

Habitat: Taken on cactus, Farman's greenhouse, Manhattan. Abundant.

1127. *Aulacaspis rosæ* (Bouche). (Rose scale.)

Aspidiotus rosæ Bouche, Naturg. Ins., p. 14 (1834).
Diaspis rosæ Comst., Rep. I. S. Dep. Ag., 1880, p. 312 (1881).
Aulacaspis rosæ Banks, Bull. 34, n. s., Div. Ent. Dep. Ag., p. 23 (1902).
" " Sanders, Cocc. Ohio, Pr. Ohio Acad. Sci., IV, Sp. Papers No. 8, p. 53 (1904).

Habitat: Taken on roses, blackberry, raspberry, Manhattan. Abundant.

1143. *Hemichionaspis aspidistræ* (Sign.).

Chionaspis aspidistræ Sign., Ann. Soc. Ent. Fr. (4), IX, p. 443 (1869).
" brasiliensis Comst., 2d Reg. Dep. Ent. Corn. Univ., p. 109 (1883).
" aspidistræ Ckll., Pr. U. S. Nat. Mus., XVII, p. 620 (1895).
" " Green, Cocc. Ceylon, pt. II, p. 110 (1899).
Hemichionaspis aspidistræ Cooley, Spec. Bull. Mass. Exp. Sta., p. 45 (1899).
" " Sanders, Cocc. Ohio, Pr. Ohio Acad. Sci., IV, Sp. Papers No. 8, p. 54 (1904).

Habitat: Taken on ferns in Baxter's greenhouse and Moore's greenhouse, Manhattan.

1199. *Aspidiotus æsculi solus* Hunter.

Aspidiotus æsculi subsp. solus Hunter, Kan. Univ. Quart., VIII, p. 12 (1899).
" " " " Newell, Contr. Ia. Ag. Coll., No. 3, p. 13 (1899).

Habitat: Taken on *Juglans nigra*, Kan. Univ. campus, Lawrence, by Prof. S. J. Hunter.

1200. *Aspidiotus ancylus* (Putn.). (Putman's scale.)

Aspidiotus ancylus Putn., Pr. Davenport Acad. Nat. Sci., II, p. 346 (1879).
Diaspis ancylus Putn., Trans. Ia. Hort. Soc., XII, p. 321 (1887).
Aspidiotus " Comst., Rep. U. S. Dep. Ag., 1880, p. 292 (1881).
" " Hunter, Kan. Univ. Quart., VIII, p. 4 (1899).
" " Sanders, Cocc. Ohio, Pr. Ohio Acad. Sci., IV, Sp. Papers No. 8, p. 57 (1904).

Habitat: Riley, Douglas, Ford, Edwards, Sedgwick and Wyandotte counties. On oak, maple, mountain ash, *Ptelea*.

1216. *Aspidiotus cyanophyli* Signoret.

Aspidiotus cyanophyli Sign., Ann. Soc. Ent. Fr., (4), IX, p. 119 (1869).
" " Comst., 2d Rep. Corn. Univ. Dep. Ent., p. 59 (1883).
" " Ckll., Bull. 6, Tec. s., Dep. Ag., p. 29 (1897).
" " Sanders, Cocc. Ohio, Pr. Ohio Acad. Sci., IV, Sp. Papers No. 8, p. 59 (1904).

Habitat: K. S. A. C. greenhouse. On *Ficus*, palms; on umbrella-plant, Lewis, Kan.

1217. *Aspidiotus cydoniæ* Comst.

Aspidiotus cydoniæ Comst., Rep. U. S. Dep. Ag., 1880, p. 295 (1881).
" " Green, Cocc. Ceylon, pt. I, p. 62 (1896).
" grenii Hunter, Kan. Univ. Quart., VIII, p. 11 (1899).

Habitat: Taken on palms in greenhouse, K. S. A. C.; taken on palm, *Howea belmoreana*, by Professor Hunter, University greenhouse, Lawrence.

1226. *Aspidiotus fernaldi albiventer* Hunter.

Aspidiotus fernaldi subsp. albiventer Hunter, Kan. Univ. Quart., VIII, p. 6 (1899).
" " " cockerelli Parr., Can. Ent., XXXI, p. 10 (1899).
" " " albiventer Newell, Contr. Ia. Ag. Coll., No. 3, p. 19 (1899).

Habitat: Riley and Douglas counties. On trunks of soft maple.

1229. *Aspidiotus forbesi* Johnson. (Cherry scale.)

Aspidiotus forbesi Johns., Ent. News, VII, p. 151 (1896).
" " Forbes, 20th Rep. Ins. Ill., p. 16 (1898).
" " Hunter, Kan. Univ. Quart., VIII, p. 3 (1899).
" " Sanders, Cocc. Ohio, Pr. Ohio Acad. Sci., IV, Sp. Papers No. 8, p. 60 (1904).

Habitat: Riley, Ford, Finney, Shawnee, Douglas, Cloud, Seward, Reno, Sedgwick and Wyandotte counties. On apple, plum, crab-apple, peach, pear, cherry, currant, apricot, ash.

1233. *Aspidiotus hederæ* (Vall.). (Oleander scale.)

Chermes hederæ Vall., Mem. Acad. Dijon., p. 30 (1829).
Aspidiotus nerii Comst., Rep. U. S. Dep. Ag., 1880, p. 301 (1881).
" hederæ Ckll., Ent. News, V, p. 211 (1894).
" nerii Osborn, Contr., Ia. Ar. Coll., p. 7 (1898).
" hederæ var. nerii Hunter, Kan. Univ. Quart., VIII, p. 11 (1899).
" " Sanders, Cocc. Ohio, Pr. Ohio Acad. Sci., IV, Sp. Papers No. 8, p. 62 (1904).

Habitat: Taken on *Areca lutescens*, oleander, K. S. A. C. greenhouse; on oranges in the market; on oleander, Atchison, Kan., by Professor Hunter.

1239. *Aspidiotus juglans-regiæ* Comst. (English Walnut scale).

Aspidiotus juglans-regiæ Comst., Rep. U. S. Dep. Ag., 1880, p. 300 (1881).
" " " Hunter, Kan. Univ. Quart., VIII, p. 8 (1899).
" " " Sanders, Cocc. Ohio, Pr. Acad. Sci., IV, Sp. Papers No. 8, p. 62 (1904).

Habitat: Taken by Professor Hunter on a young crab-apple tree, Lawrence. On peach, Ashland bottom, Manhattan. Quite common.

1241. *Aspidiotus lataniæ* Sign.

Aspidiotus lataniæ Sign., Ann. Soc. Ent. Fr., (4), IX, p. 124 (1869).
" " Newell, Contr. Iowa Ag. Coll., No. 3, p. 31 (1899).
" " Sanders, Cocc. Ohio, Pr. Ohio Acad. Sci., IV, Sp. Papers No. 8, p. 63 (1904).

Habitat: Taken on palm, Baxter's greenhouse, Manhattan; on rose, Moore's greenhouse, Manhattan.

1250. *Aspidiotus osborni* Newell & Ckll.

Aspidiotus osborni Newell & Ckll., Rep. Iowa Acad. Sci., V, p. 229 (1898).
" " Hunter, Kan. Univ. Quart., VIII, p. 5 (1899).
" " Newell, Bull. 43 Iowa Exp. Sta., p. 165 (1899).

Habitat: Taken on honey-locust by Professor Popenoe at Dodge City; on *Quercus alba* by Professor Hunter at Lawrence.

1252. *Aspidiotus ostreæformis* Curt. (Pear-tree oyster scale.)

Aspidiotus ostreæformis Curt. (Ruricola), Gard. Chron., III, p. 805 (1843).
" " Felt, Bull. 46, N. Y. St. Mus., pp. 323, 352 (1901).
" " Banks, Bull. 34, n. s., Div. Ent. Dep. Ag., p. 18 (1902).
" " Sanders, Cocc. Ohio, Pr. Ohio Acad. Sci., IV, Sp. Papers No. 8, p. 64 (1904).

Habitat: Taken by Parrott, Manhattan.

1256. *Aspidiotus perniciosus* Comst. (San Jose scale.)

Aspidiotus perniciosus Comst., Rep. U. S. Dep. Ag., 1880, p. 304 (1881).
" " Howard, Yearbook U. S. Dep. Ag., p. 267 (1894).
" " Howard, Bull. 12, n. s., Div. Ent. U. S. Dep. Ag. (1898).
" " Webster, Bull. 72, Ohio Exp. Sta., p. 211 (1896).
" " Felt, Bull. 46, N. Y. St. Mus., pp. 304, 349 (1901).
" " Sanders, Cocc. Ohio, Pr. Ohio Acad. Sci., IV. Sp. Papers No. 8, p. 65 (1904).
" " Surface, Mo. Bull. Div. Zoöl., Pa. Dep. Ag., III, p. 304 (1906).
" " Popenoe, Press Bull. 150, Kan. Exp. Sta. (1906).

Habitat: Taken on apple, Osage orange, peach, grape, cottonwood, Dodge City (abundant on trees in the city), April, 1906, by Prof. E. A. Popenoe. Taken on apple at Alden, July, 1906. Taken on apple and peach at Kansas City, Kan., March 12, 1907, by Prof. E. A. Popenoe. Taken on apple at Hutchinson, December, 1908 (sent to the Department of Entomology, Kansas Experiment Station). Taken on apple, peach, plum, at Wichita, April 12, 1907. Taken on apple at Larned, December 3, 1908 (sent to the Department of Entomology). Taken on apple and rose at Haysville, January 13, 1907. Taken on apple, peach, plum, grape, etc., Kansas City, Kan., 1908.

1261. *Aspidiotus rapax* Comst. (Greedy scale.)

Aspidiotus rapax Comst., Rep. U. S. Dep. Ag., 1880, p. 307 (1881).
" camelliæ Green, Cocc. Ceylon, pt. I, p. 60 (1896).
" rapax Sanders, Cocc. Ohio, Pr. Ohio Acad. Sci., IV, Sp. Papers No. 8, p. 67 (1904).

Habitat: Taken on oranges in the market, Manhattan; on orange fruit in K. S. C. A. greenhouse.

1270. *Aspidiotus ulmi* Johnson.

Aspidiotus ulmi Johns., Bull. Ill. St. Lab. Nat. Hist., IV, p. 388 (1896).
" " Hunter, Kan. Univ. Quart., VIII, p. 6 (1899).
" " Sanders, Cocc. Ohio, Pr. Acad. Sci., IV, Sp. Papers No. 8, p. 67 (1904).

Habitat: Taken on trunks of elm and catalpa, Lawrence, by Professor Hunter; on elm, at Topeka, by E. A. Popenoe; on elm and catalpa, K. S. A. C. campus, Manhattan.

1272. *Aspidiotus uvæ* Comst. (Grape scale.)

Aspidiotus uvæ Comst., Rep. U. S. Dep. Ag., 1880, p. 309 (1881).
" " Newell, Contr. Ia. Ag. Coll., No. 3, p. 12 (1899).
" " Sanders, Cocc. Ohio, Pr. Ohio Acad. Sci., IV, Sp. Papers No. 8, p. 68 (1904).

Habitat: On grape-vines, Manhattan, Iola, and Wichita; Wyandotte county.

1294. *Chrysomphalus aonidum* (Linn.).

Coccus aonidum Linn., Syst. Nat., Ed. X, I, p. 455 (1758).
Aspidiotus ficus Comst., Rep. U. S. Dep. Ag., 1880, p. 296 (1881).
Chrysomphalus ficus Ashm., Am. Ent., III, p. 267 (1880).
" aonidum Ckll., Biol. Centr. Amer., II, pt. 2, p. 25 (1899).
" " Sanders, Cocc. Ohio, Pr. Ohio Acad. Sci., IV, Sp. Papers No. 8, p. 70 (1904).

Habitat: Taken on palms, K. S. A. C.; Baxter's greenhouse, Manhattan.

1295. *Chrysomphalus aurantii* (Mask). (Red scale of California.)

Aspidiotus aurantii Mask., N. Z. Trans., XI, p. 199 (1878).
" " Comst., Rep. U. S. Dep. Ag., 1880, p. 293 (1881).
" " Green, Cocc. Ceylon, pt. I, p. 58 (1896).
" " Marlatt, Yearbook U. S. Dep. Ag., p. 268 (1900).
" " Sanders, Cocc. Ohio, Pr. Ohio Acad. Sci., IV, Sp. Papers No. 8, p. 71 (1904).

Habitat: Taken on *Opuntia*, K. S. A. C. greenhouse, by J. B. Norton.

1300. *Chrysomphalus dictyospermi* (Morg).

Aspidiotus dictyospermi Morg., Ent. Mon. Mag., XXV, p. 352 (1889).
" " Ckll., Can. Ent., XXVI, p. 128 (1894).
" (Chrysomphalus) dictyospermi Ckll., Bull. 6, U. S. Dep. Ag., p. 23 (1897).
" dictyospermi Sanders, Cocc. Ohio, Pr. Ohio Acad. Sci., IV, Sp. Papers No. 8, p. 71 (1904).

Habitat: On palm in Moore's greenhouse, Manhattan, and lemon leaves, Moore's greenhouse.

1305. *Chrysomphalus obscurus* (Comst.).

Aspidiotus obscurus Comst., Rep. U. S. Dep. Ag., 1880, p. 303 (1881).
" " Hunter, Kan. Univ. Quart., VIII, p. 7 (1899).
Chrysomphalus obscurus Leon., Riv. Pat. Veg., VII, p. 205 (1899).
" " Sanders, Cocc. Ohio, Pr. Ohio Acad. Sci., IV., Sp. Papers No. 8, p. 72 (1904).

Habitat: On Black oak, Douglas county, by Professor Hunter.

1335. *Targionia helianthi* (Parr).

Aspidiotus (Targionia) helianthi Parr., Can. Ent., XXXI, p. 176 (1899).

Habitat: Kansas. On roots of sunflower (*Helianthus*). Taken by Parrott, Hackberry glen, Riley county.

1336. *Targionia marlatti* (Parr).

Aspidiotus (Targionia) marlatti Parr., Can. Ent., XXXI, p. 282 (1899).
" " " Parr., Bull 98, Kan. Exp. Sta., p. 143 (1900).

Habitat: Kansas. On *Andropogon furcatus, A. scoparius, Panicum virgatum, Chrysopogon.* Taken by J. B. Norton, on Bluemont, Riley county.

1377. *Lepidosaphes beckii* (Newm). (Purple scale.)

Coccus beckii Newm., The Entom., IV, p. 217, Feb. (1869).
Aspidiotus citricola Glover, Rep. U. S. Dep. Ag., 1876, p. 43 (1877).
Mytilaspis citricola Comst., Rep. U. S. Dep. Ag., 1880, p. 321 (1881).
Lepidosaphes beckii Sanders, Cocc. Ohio, Pr. Ohio Acad. Sci., IV, Sp. Papers No. 8, p. 73 (1904).

Habitat: Taken on oranges in the market, Manhattan.

1431. *Lepidosaphes ulmi* (Linn). (Oyster-shell scale.)

Coccus ulmi Linn., Syst. Nat. Ed. X, I, p. 455 (1758).
Mytilaspis pomorum Comst., Rep. U. S. Dep. Ag., 1880, p. 325 (1881).
" " Osborn, Contr. Ia. Ag. Coll., p. 4, (1898).
" " Hunter, Kan. Univ. Quart., VIII, p. 14 (1899).
" " Cooley, 6th Rep. Mont. Exp. Sta., p. 85 (1899).
Lepidosaphes ulmi Sanders, Cocc. Ohio, Pr. Ohio Acad. Sci., IV, Sp. Papers No. 8, p. 74 (1904).

Habitat: Taken on apple, blackberry, currant, lilac, raspberry. Abundant on lilacs. The lilacs were dying. Manhattan.

1442. *Parlatoria pergandii* Comst. (The chaff scale.)

Parlatoria pergandii Comst., Rep. U. S. Dep. Ag., 1880, p. 327 (1981).
" " Hunter, Kan. Univ. Quart., IX, p. 105 (1900).
" " Sanders, Cocc. Ohio, Pr. Ohio Acad. Sci., IV, Sp. Papers No. 8, p. 75 (1904).

Habitat: On *Agava*, K. S. A. C. greenhouse, and on orange, Waterloo.

1445. *Parlatoria proteus* (Curt.).

Aspidiotus proteus Curt., Gard. Chron., p. 676 (1843).
Parlatoria proteus Comst., 2d Rep. Dep. Ent. Corn. Univ., p. 114 (1883).
" " Hunter, Kan. Univ. Quart., IX, pp. 105, 106 (1900).

Habitat: Taken on *Ficus*, K. S. A. C. greenhouse.

ADDITIONAL RESULTS OF COLLECTING INSECTS IN KANSAS AND COLORADO.

By E. S. TUCKER, Bureau of Entomology, United States Department of Agriculture, Washington, D. C.

THE classification of insects in all orders requires a wide diversification of study, which, beyond a limited extent, cannot be perfected by any one person, even under the most favorable circumstances. In working upon the specimens of my own collecting, the need of complete knowledge concerning some forms necessarily curtails the systematic treatment of species.

Under the title of "Some Results of Desultory Collecting of Insects in Kansas and Colorado," a record is given of my former work regarding insects which were personally collected. As mentioned at the end of this paper, which was published in the Kansas University *Science Bulletin* (vol. IV, No. 2), a considerable amount of material remained to be reported upon, my intention being to present the results in future lists. The greater part of the additional material consisted of hymenopterous insects, all the specimens having been collected by myself under conditions which have been explained in my former paper already mentioned. As intimated, not all of these specimens have been fully studied, but the work of specific determination has advanced to such an extent as to deserve a presentation of the results at this time rather than to subject them to further delay in publication. So far as these results are given, every record for a species contributes toward a better knowledge of geographical distribution and seasonal occurrence.

LIST OF HYMENOPTERA.

The tabulated summary which appears at the end of this list shows the number of species newly recorded for Kansas, and of species taken in both Kansas and Colorado, as well as in each state separately, and also the total number reported, all being arranged with reference to each family as treated. In regard to the species hitherto reported as occurring in Kansas, reference must be given to two papers: One, under the title of "Preliminary List of the Hymenoptera of Kansas," was published by Prof. F. H. Snow in Transactions of the Kansas Academy of Science, volume VII, pp. 97–101; and the other, entitled "A List of Kansas Hymenoptera," by J. C. Bridwell, appeared in volume XVI, pp. 203–211, of the Transactions. The names of those species which I report as being new to

the Kansas list have not been cited in either of the preceding papers.

The scheme of classification outlined by Dr. W. H. Ashmead has been used as a guide for the arrangement of my list, notwithstanding some lack of conformity on my part with regard to revised nomenclature. The work of determination was carried on by myself so far as circumstances permitted, and it covered most of the material; otherwise the specimens were submitted to specialists for study. Mr. H. L. Viereck has identified many species, a number of which he described as new. Mr. Chas. T. Brues has also aided in similar work which dealt principally with parasites. Credit is given in the proper places to other authorities who have assisted me. Wherever the name of a new species is cited, reference is made to the distinction of the type according to Lord Walsingham's designations concerning type specimens. The descriptions published individually by Viereck and Brues establish 58 new species and varieties by name, which pertain to specimens collected by myself, in families as follows: Pemphredonidæ, 2 by Viereck; Trypoxylidæ, 1 by Viereck; Eumenidæ, 1 by Viereck; Ichneumonidæ, 23 by Viereck and 2 by Brues; Alysiidæ, 4 by Viereck; and Braconidæ, 24 by Viereck and 1 by Brues. In addition, one new variety in the family Anthophoridæ, and one new species in the family Eumenidæ, are founded upon my own names and descriptions, which are incorporated in my list herewith.

Family Apidæ.

Apis mellifica L. Kansas and Colorado.

Family Bombidæ.

(Mr. E. S. G. Titus kindly reported a few names of species, including *B. consimilis* Cr. from Venango county, Pennsylvania.)

Bombus appositus Cr. Colorado, Buffalo; August.

- californicus Sm. Colorado, Tabernash; August. (Det. by H. J. Franklin.)
- fervidus Fab. Males, formerly listed as *Apathus elatus* Fab. (Kansas, Wichita; August. Colorado, Colorado Springs and Denver; August.
- flavifrons Cr. Colorado, Colorado Springs, in Garden of the Gods; July. Cheyenne cañon, near Colorado City; August. Buffalo; August.
- howardii Cr. Colorado, Buffalo; August.
- morrisoni Cr. Colorado, Colorado Springs; August.
- pennsylvanicus Cr. Kansas, Lawrence; May; July; July, twilight; August; September Wichita; August.
- proximus Cr. Colorado, Buffalo; August.
- rufocintus Cr. Colorado, Colorado Springs; August. (Det. by H. J. Franklin.)

Family BOMBIDÆ.

Bombus scutellaris Cr. Kansas, Wichita; August.
separatus Cr. Kansas, Lawrence; May, twilight.
virginicus Oliv. Kansas, Lawrence; July; July, twilight; September; October.

Family SARCOPHAGIDÆ.

Sarcophaga *ægra* Wk. July.
Helicobia (Sarcophaga) quadrisetosa Coq. June; July; July, twilight.

Family MUSCIDÆ.

Calliphora coloradensis Hough. April.

Family ANTHOMYIDÆ.

Homalomyia canicularis L. July.
scalaris Fab. May; May, twilight; June; June, twilight; July. Wichita; April.
Cœnosia flavicoxa Stein. April; May; July. Wichita; April.

Family HELOMYZIDÆ.

Œcothea fenestralis Fal. May.
Leria caccabata Tkr., n. sp. May.

Family ORTALIDÆ.

Chrysomyza demandata Fab. October.

Family OSCINIDÆ.

Ectecephala albistylum Macq. June; July, twilight.

Family AGROMYZIDÆ.

Odinia ornata Zett. July.

Family ANTHOPHORIDÆ.

Clisodon terminalis Cr. Colorado, Tabernash; August.
Anthophora abrupta Say. Kansas, Lawrence; May, twilight; June, twilight.
occidentalis Cr. Colorado, Colorado Springs; August.
smithii Cr. Colorado, Colorado Springs, August.
Melissodes agilis Cr. Colorado Springs, August. Denver, August.
agilis Cr., var. snowii Cr. Colorado, Denver; August.
aurigenia Cr. Colorado, Colorado Springs, in Garden of the Gods; July; Denver, August.

On account of the close resemblance of *M. agilis* to *M. snowii* and *M. aurigenia*, a comparative study of authentic and typical specimens in the collection of the University of Kansas was undertaken for the purpose of finding reliable characters for accurate identifications of other examples, including those collected by myself. In the case of *agilis* and *aurigenia*, reliance was placed upon examples authenticated by Mr. E. T. Cresson: and for *snowii*, a specimen was found bearing the Colorado label of F. H. Snow, and although lacking a name label, it had evidently been collected with the type specimen, or at least under the same circumstances. This insect is

entitled to consideration as a paratype because the particular pin label, "Col. Snow," unquestionably places it with material from which the type was taken. The fact that this specimen was found unnamed at the time of my examination does not disprove its true relation.

Since female specimens were not fully represented in the three forms, the results of study have been obtained by comparisons of male examples, in accordance with a scheme for the consideration of characters in relative groups as shown by the following arrangement of the original descriptions.

	Melissodes agillis Cr. (Described from 6 specimens.)	*Melissodes aurigenia* Cr. (Described from 20 specimens.)	*Melissodes snowii* Cr. (Described from 1 specimen.)
General color and vestiture.	(1) Small, black, clothed with pale ochraceous or cinerous pubescence, dense on thorax.	(Description for female applies to male.) Black; head, legs and basal segments of abdomen clothed with ochraceous pubescence, the thorax with dense fulvous pubescence, paler on sides and beneath. Male more pubescent than female.	Black, clothed with dense white pubescence.
Lower face and mouth parts.	(2) Clypeus, labrum, and spot on base of mandibles pale yellow; mandibles dull ferruginous at tips.	Clypeus, labrum, and spot on base of mandibles pale yellow.	Clypeus, labrum, and spot at base of mandibles yellowish white.
Antennæ.	(3) Antennæ nearly as long as the body, fulvous, darker above, three basal joints black, third joint a little larger than second.	Antennæ two-thirds the length of body, third joint less than twice the length of second, flagellum pale fulvous beneath.	Antennæ two-thirds the length of body, second and third joints subequal, flagellum fulvous, the base of joints above black.
Wings.	(4) Wings whitish-hyaline, with pale testaceous nervures, second submarginal cell half the length of first, third rounded at tip and narrowed one-half toward marginal.	(Description for female applies to male.) Wings uniformly pale, nervures pale fulvous, second submarginal cell more than half the length of first, the third truncate at tip and narrowed one-half to marginal.	Wings uniformly whitish-hyaline, nervures pale fulvous, second submarginal less than half the length of first, the third broadly rounded at tip, and narrowed one-half toward marginal.
Legs.	(5) Legs clothed with short cinerous pubescence, tarsi slender, simple, pale, ferruginous at tips, tibial spurs white.	Legs slender, with ochraceous pubescence, tips of tarsi pale fulvous, tibial spurs white.	Tips of tarsi pale ferruginous.
Abdomen.	(6) Abdomen thinly clothed with cinerous pubescence, apical margin of the segments rather broadly whitish, and having a narrow band of cinerous pubescence, two apical segments each with a short stout tooth at extreme sides.	Apical margin of abdominal segments pale testaceous, first segment clothed with a long fulvo-ochraceous pubescence, base of second and apical margin of segments 2–6 with a broad, more or less indistinct band of ochraceous pubescence, two apical segments each with a stout black tooth on extreme sides.	Apical margin of abdominal segments whitish and having a fascia of dense white pubescence; two apical segments each with a tooth on extreme sides; venter clothed with white pubescence.
Size.	(7) Length, 0.40 inch.	Length, 0.40–0.45 inch.	Length, 0.40 inch.

My critical remarks herewith follow:

(1) The pubescence on the thorax of *aurigenia* has a richer fulvous tinge and generally appears longer and denser than with *agilis* or *snowii*, such vestiture on *snowii* being usually cinerous.

(2) In all examples representing the three forms, so far as examined, the labrum is more or less black on the outer edges, and in some cases wholly black with *agilis*. The size of the yellow spot when present on labrum is seldom uniform among specific examples, and this inconstancy is especially noticeable with *agilis*, which may not only lack a yellow spot on labrum, but also on base of mandibles. Prof. T. D. A. Cockerell has characterized *snowii* as having a dark labrum with a large yellow spot. In such respects this disposition of colors is conspicuously marked on a specimen which, as already stated, should be regarded as a paratype of *snowii*.

(3) Little dependence can be placed on the color of the third joint of antennæ always being black with *agilis*, since fulvous color may as likely appear on the second as well as the third joint as with *aurigenia* or *snowii*. If the descriptive reference to "three basal joints black" were strictly employed, a new name would be required to designate those specimens with such slight variation. There seems to be good reason, however, in applying the description of *snowii* precisely with regard to an almost entirely fulvous flagellum, which I consider the distinguishing feature. The specimens of this form collected by me have the flagellum scarcely darkened above and merely marked with fine transverse lines or dashes at the extreme base and apex of each joint.

(4) The size and relative shape of the second submarginal cell in comparison with the first are variable; hence they cannot be relied upon to furnish stable characters. In no case has the second submarginal cell appeared to be less than half the length of the first as stated for *snowii*, and even most examples of *agilis* show it to be larger than one-half. If descriptive characters of this nature were strictly insisted upon, a useless array of new names would be necessary to designate specimens with such uncertain variations. What I regard as a case of individual mutation is displayed by an example of *snowii* on account of the nervure enclosing the third submarginal cell being forked distinctly appendiculate outwardly from the upper corner instead of being rounded.

(5) All are alike in these respects.

(6) The second abdominal segment of *aurigenia* has a distinct basal band which is lacking on *snowii*, while *agilis* in perfect condition has a thin basal line or rather a fringe of usually erect pubescence, which, if depressed from the effect of moisture or smearing, greatly resembles a band. The description of *aurigenia* fails to state that the first abdominal segment is apically fasciate, as shown by perfect or unrubbed specimens.

(7) All agree in uniform size.

In consequence, I present my deductions mainly embodied in a table for the separation of the males of these three forms. In my opinion, *aurigenia* should be entitled to recognition as a species distinct from *agilis* or *snowii*, but the latter two names evidently apply to one species, although *snowii* can be conveniently retained as a varietal name of *agilis*.

1. Pubescence of dorsum of thorax rich fulvous, extra long and dense; second abdominal segment with a distinct basal and apical band, *aurigenia*.
   Pubescence cinerous to ochraceous; second abdominal segment with apical band only, basal fringe not considered as a band, 2.

2. Flagellum of antennæ fulvous beneath, black above, third basal joint sometimes black, *agilis*.
   Flagellum of antennæ almost wholly fulvous, scarcely darkened above, and merely marked with fine transverse black lines or dashes at extreme base and apex of each joint, *agilis*, var. *snowii*.

In a paper entitled "The Bees of Boulder County, Colorado," published by Prof. T. D. A. Cockerell, in University of Colorado Studies, volume IV, No. 4, other varieties of *agilis* are designated according to the absence or presence of a yellow spot on labrum and mandibles.

Melissodes bimaculata Lep. (=binotata Say). Kansas, Lawrence; July.
grindeliæ Ckll. Colorado, Manitou; August.
lupina Cr., new var. composita. Colorado, Colorado Springs; August, 1906. Types: three male specimens.

Black, clothed with grayish pubescence, somewhat fulvous on dorsum of thorax; clypeus yellow, except lower fulvous edge and a black line on each side reaching nearly half way down from the upper angle; labrum yellow unless darkened on sides; mandibles with basal yellow spot and fulvous stripe before the tip; antennæ two-thirds the length of the body, three basal joints wholly black, the third joint about twice the size of the second, following joints ferruginous beneath, black above; eyes greenish; tegulæ shining dusky brown to piceous, pubescent; wings dusky hyaline with apical margin faintly cloudy, nervures dark fuscous, second submarginal cell nearly square and receiving the first recurrent nervure at two-thirds of its length, third cell rounded behind on upper portion and narrowed less than one-half its length against the marginal.

Abdomen shining, segments 1 to 4 broadly margined behind with testaceous, which also shows on the posterior edge of the fifth segment; basal segment clothed with long, sparse, white pubescence, subfasciate on apical margin for entire length in case it has not been denuded; second to fourth segments each with a subapical fascia of whitish appressed but rather loose pubescence, curved inwardly at middle but reaching apical margin at sides, a subbasal line of thinner pubescence diffused at middle on the second segment, apical segments covered with dense pubescence which entirely conceals the sixth with a darker shade of fulvous; a black tooth projects from the base on each side of three apical segments, the posterior pair being acute, the middle one extra large and stout, and the anterior small and short, except on one specimen, which has only four distinct teeth at sides, besides having all the fasciæ fulvous in color; venter clothed with long grayish pubescence on the sides, apical margins with appressed fulvous pubescence. Length, 10 mm.

These examples differ decidedly from *M. agilis* and its evident variety *M. snowii*, and also from *M. aurigenia*, on account of darker nervures of wings, arcuate fasciæ of ab-

dominal segments 2 to 4, and stouter middle and posterior legs with only the last joint of their tarsi pale ferruginous.

From typical *lupina*, the main differences may be noted by reference to the description by Cresson. As my specimens have been examined by Prof. T. D. A. Cockerell, his remarks concerning them are published in an accompanying paper, under the title of "Notes upon Variation of *Melissodes lupina* Cr.

Melissodes menucha Cr. Colorado, Colorado Springs, in Garden of the Gods; July.
obliqua Say. Kansas, Lawrence; July. Wichita; August.

Family NOMADIDÆ.

Epeolus compactus Cr. Kansas, Wichita; August. New to the Kansas list.
Triepeolus lunatus Say. Kansas, Lawrence; July. Wichita; August.
occidentalis Cr. Colorado, Colorado Springs; August.
remigatus Fab. Kansas, Wichita; August.

Family CERATINIDÆ.

Ceratina dupla Say. Kansas, Lawrence; May.

Family MEGACHILIDÆ.

Osmia lignaria Say. Kansas, Lawrence; April.
Megachile latimanus Say. Colorado, Colorado Springs and Denver; August.
manifesta Cr. Colorado, Colorado Springs and Denver; August.
montivaga Cr. Colorado, Buffalo; August.
perbrevis Cr. Colorado, Denver; August.
petulans Cr. Kansas, Lawrence; July. New to the Kansas list.
pruina Sm. Colorado, Colorado Springs; August.
Anthidium emarginatum Say. Colorado, Buffalo; August.
porteræ Ckll. (= maculifrons Cr.). Colorado, Colorado Springs; August.
Dianthidium pudicum Cr. Colorado, Buffalo; August.
Sayi Ckll. (= interruptum Say). Colorado, Colorado Springs; August.

Family STELIDÆ.

Neolarra pruinosa Ash. Colorado, Denver; August. (Det. by E. S. G. Titus.)
Cœlioxys deplanata Cr. Colorado, Colorado Springs; August. (Det. by T. D. A. Cockerell.)
dubitata Sm. (Probably female of *rufitarsus* Sm.). Colorado, Denver; August.

Family PANURGIDÆ.

(Assistance in the work of determination was kindly rendered by Mr. E. S. G. Titus.)

Halictoides marginatus Cr. Colorado, Buffalo; August.
Purdita zebrata Cr. Colorado, Denver; August.
Panurginus albitarsis Cr. Colorado, Colorado Springs; August.
ornatipes Cr. Colorado, Colorado Springs; August.
Calliopsis andreniformis Sm. Kansas, Lawrence; June; July.

Family ANDRENIDÆ.

(Most of the species of *Halictus* were determined by E. S. G. Titus and J. C. Crawford.)

Parandrena andrenoides Cr. Colorado, Colorado Springs; April.
Augochlora fervida Sm. Kansas, Wichita; September.
pura Say. Kansas, Lawrence; May; June; July; August.
Agapostemon viridulus Fab. Kansas, Lawrence; July; August. Colorado, Denver and Colorado Springs; August.
texanus Cr. Kansas, Lawrence; July.
Halictus bruneri Cwfd. Kansas, Lawrence; May. New to the Kansas list.
galpinsiæ Ckll. Colorado, Colorado Springs and Buffalo; August.
ligatus Say. Kansas, Wichita; August. Colorado, Colorado Springs; August.
macoupiensis Robt. Kansas, Lawrence; May. New to the Kansas list.
perdifficilis Ckll. Colorado, Denver; August.
pilosus Sm. Kansas, Lawrence; July. New to the Kansas list.
provancheri D. T. Colorado, Colorado Springs; April; August.
pruinosiformis Cwfd. Colorado, Colorado Sprıngs; August.
sparsus Robt. Kansas, Lawrence; June; July; September. New to the Kansas list.
tegularis Robt. Colorado, Buffalo; August.
versatus Robt. Kansas, Lawrence; April; June; July; August; September. New to the Kansas list.
zephyrus Sm. Kansas, Lawrence; June, twilight; July; July, twilight. New to the Kansas list.

Family OXYBELIDÆ.

Notoglossa emarginata Say. Kansas, Wichita; September.

Family CRABRONIDÆ.

Paranothyreus cognatus Fox. Kansas, Lawrence; June. New to the Kansas list.
snowii Fox. Kansas, Lawrence; June. New to the Kansas list.
Thryeopus coloradensis Pack. Colorado, Colorado Springs; August.
Stenocrabro tarsalis Fox. Kansas, Lawrence; June. New to the Kansas list.
Rhopalum rufigaster Pack. Kansas, Lawrence; July. New to the Kansas list.

Family PEMPHREDONIDÆ.

Stigmus inordinatus Fox. Colorado, Denver; August.
Passalœcus annulatus Say. Kansas, Lawrence; August.
equalis Vr. Kansas, Lawrence; August (type). Addition to the Kansas list.
Diodontus brunneicornis Vr. Kansas, Wichita; September (type). Addition to the Kansas list.
Mimesa argentifrons Cr. Kansas, Lawrence; June. New to the Kansas list.
unicincta Cr. Kansas, Lawrence; June. New to the Kansas list.
Psen punctata Fox. Colorado, Colorado Springs; August.

Family BEMBECIDÆ.

Bembex nubilipennis Cr. Kansas, Wichita; August.
spinolæ Lep. (=fasciata Fab.). Kansas, Lawrence; June; July. Colorado, Denver; August.
Microbembex monodonta Say. Kansas, Lawrence; August.

Family LARRIDÆ.

Notogonia argentata Beauv. Kansas, Lawrence; August; September; October.
Tachytes obscurus Cr. Kansas, Lawrence; July. New to the Kansas list.
spatulatus Fox. Colorado, Colorado Springs; August.
Tachysphex tarsatus Say. Colorado, Buffalo; August.

Family PHILANTHIDÆ.

Cerceris bicornuta Guer. (?=venator Cr.). Kansas, Wichita; August.
finitima Cr. Kansas, Lawrence; July. Wichita; August.
Aphilanthops laticinctus Cr. Colorado, Colorado Springs; August.
Philanthus crabroniformis Sm. Colorado, Denver; August.
punctatus Say. Kansas, Lawrence; June.

Family TRYPOXYLIDÆ.

Trypoxylon albipilosum Fox. Kansas, Lawrence; June; August.
bidentatum Fox. Kansas, Lawrence; June. New to the Kansas list.
clavatum Say. Kansas, Lawrence; June; August.
quintilis Vr. Kansas, Lawrence; July (type). Addition to the Kansas list.
texense Sauss. Colorado, Colorado Springs; August.

Family MELLINIDÆ.

Mellinus rufinodus Cr. Colorado, Denver; August.
Euspongus bipunctatus Say. Kansas, Lawrence; June; July.

Family NYSSONIDÆ.

Alyson melleus Say. Kansas, Lawrence; June; July.

Family STIZIDÆ.

Sphecius speciosus Drury. Kansas, Lawrence; July; August.

Family SPHECIDÆ.

Proterosphex ichneumonea L. Kansas, Lawrence; July.
pennsylvanica L. Kansas, Lawrence; June; July; August.
Isodontia azteca Sauss. (=macrocephalus Fox). Kansas, Lawrence; May; July. New to the Kansas list.
Chalybion cæruleum L. Kansas, Lawrence; June; July.
Prionony x atrata Lep. Kansas, Wichita; August.
atrata Lep., var. brunnipes Cr. Kansas, Lawrence; August. New to the Kansas list.

Psammophila argentifrons Cr. Colorado, Colorado Springs; August.
communis Cr. Colorado, Cheyenne cañon, near Colorado City; July. Manitou; August.
luctuosa Sm. Colorado, Denver, Buffalo, and Colorado Springs; August.

Ammophila aberti Hald. (Evidently identical with *yarrowi* Cr.). Colorado, Colorado Springs; August.
extrematata Cr. Colorado, Colorado Springs; August.
gryphus Sm. (Probably female of *macra* Cr.) Kansas, Wichita; August. New to the Kansas list.
intercepta Lep. Kansas, Lawrence; August; September. Wichita; August.
macra Cr. (Probably male of *gryphus* Sm.). Colorado, Cheyenne cañon, near Colorado City; July.
pruinosa Cr. Colorado, Denver; August.
vulgaris Cr. Colorado, Cheyenne cañon, near Colorado City; July. Colorado Springs; August.
yarrowi Cr. (See *aberti* Hald.)

Sceliphron (Pelopœus) cementarius Drury. Kansas, Lawrence; June and July, entering rooms.

Family CEROPALIDÆ.

Priocnemis fulvicornis Cr. Kansas, Lawrence; July; August. Wichita, August.
nigripes Cr. Kansas, Lawrence; April.
texanus Cr. Kansas, Wichita; August. New to the Kansas list.

Agenia architecta Say. Kansas, Lawrence; May; October. Colorado, Colorado Springs; August.

Ferreola subviolaceus Cr. Colorado, Colorado Springs; August.

Sophropompilus ingenuus Cr. Colorado, Colorado Springs; August.
relativus Fox. Kansas, Lawrence; June. New to the Kansas list. Colorado, Colorado Springs and Manitou; August.

Anoplius fuligidus Cr. Colorado, Colorado Springs; August.
funereus Lep. Kansas, Wichita; August. New to the Kansas list.
marginatus Say. Kansas, Lawrence; June.
tenebrosus Cr. Colorado, Colorado Springs; August.

Ceropales fraterna Sm. Kansas, Lawrence; June.

Family VESPIDÆ.

Vespa diabolica Sauss. Colorado, Green Mountain Falls; Cheyenne cañon and Manitou; July. Denver and Buffalo; August.
germanica Fab. Kansas, Lawrence; May; June, twilight; September.
maculata L. Colorado, Colorado Springs; August. Specimens of this species and of *vulgaris* L., collected in Venango county, Pennsylvania, recall episodes of my early attempts at collecting.
occidentalis Cr. Kansas, Lawrence; August; October. Colorado, Manitou; July.

Polistes aurifer Sauss. Colorado, Colorado Springs; August.
canadensis L. Kansas, Lawrence; July; August.
exclamans Vr. Kansas, Lawrence; May; August; November, inside windows. Additions to the Kansas list.

These examples agree in almost every particular with type specimen, which, however, lacks antennæ. The antennal joints are reddish brown excepting the middle of the flagellum, which is infuscated, principally on the upper surface. With one specimen the brown space of clypeus is reduced to a mere vertical line, and the posterior surfaces of middle and hind coxæ are

almost wholly yellow, at least without distinct separation of two oblique bands. This form resembles very closely *P. minor* Beauv., collected by me in northern Texas, and raises a question whether *exclamans* is not indeed a highly colored variety of *minor*.

Polistes variatus Cr. Kansas, Lawrence; April to August.
Polybia flavitarsis Sauss. Colorado, Manitou and Buffalo; August.

Family EUMENIDÆ.

Zethus spinipes Say. Kansas, Lawrence; July. New to the Kansas list.
Eumenes coloradensis Cr. Colorado, Colorado Springs and Buffalo; August.
fraternus Say. Kansas, Lawrence; July.
Nortonia symmorpha Sauss. Kansas, Lawrence; July.
Odynerus (Leionotus) annulatus Say. Colorado, Colorado Springs; August.
anormis Say. Kansas, Lawrence; May; July; August.
leionotus Vr. Kansas, Lawrence; July (type). Addition to the Kansas list.
pedestris Sauss. Kansas, Lawrence; June.
Ancistrocerus behrensii Cr. Colorado, Buffalo; August.
campestris Sauss. Kansas, Lawrence; May. One specimen lacks yellow apical margin on third abdominal segment.
capra Sauss. Kansas, Lawrence; data missing. New to the Kansas list.
catskillensis Sauss. Kansas, Lawrence; May; July. New to Kansas list. The specimen collected in the latter month has the yellow border of first abdominal segment somewhat enlarged on the sides. Colorado, Denver; August.
Variety *a*. Colorado, Colorado Springs and Denver; August. Two specimens show mutations as follows: One with oblique yellow line connecting with the border on sides of the second abdominal segment; the other with small disconnected spots instead of the oblique yellow line.
In studying the variations of color markings in this species, variety *d* was identified from material collected by myself in Venango county, Pennsylvania.
All of the above examples are females.
fulvipes Sauss. Kansas, Lawrence; August. New to the Kansas list.
tenuatus, n. sp. Colorado, Denver; August, 1906. Type; one female specimen.
Collected with *catskillensis* Sauss. and other varieties, to which it bears a very close resemblance, but the elongated thorax of this specimen presents a structural difference of sufficient importance to entitle the insect to recognition as a distinct species.
Thorax a little more than twice as long as the greatest width between base of wings; body feebly shining, black with yellow markings, pubescence extremely scanty, fulvous on dorsum of thorax, fuscous on front of head above antennal insertions, otherwise cinerous

and generally very fine and short, but longer on cheeks, lateral angles of metathorax, and basal segment of abdomen; punctures on head small, coarse on thorax, and all confluent; abdomen finely and rather thickly punctured. Flagellum of antennæ scarcely tinged with fulvous color on under side at tip.

Clypeus equal in length and breadth, lower sides oblique, extremity subbidentate, punctures coarse and elongate, confluent, upper and lower edges black, yellow inwardly except a large central black space which extends downward from upper edge, gradually increasing in width until it suddenly terminates with two incurved margins meeting in a point below the middle.

The other yellow ornamentation are as follows: Spot at base of mandibles; lower surface of scape; spot on front almost between antennal insertions; small dash behind the upper portion of each eye; upper margin of prothorax narrowly in front but rather broadly outwardly; tegulæ except fulvous spot in middle; spot beneath on pleuræ; spot on each side of scutellum, and all of postscutellum (which is rounded behind), and the apical margins of five abdominal segments above and below, with an apical spot on upper side of apex.

The first abdominal margin is abruptly enlarged on sides and very narrow beneath; all margins on the upper side are more or less sinuate in front, and together with those on the venter curve forwards on the lateral edges. The second to fourth ventral margins are wide, excepting an arcuate constriction on fore edge near each side.

Legs yellow, except the femora, which are pale only at tip, but rather obliquely so on the sides of the anterior and middle pair, and all the tarsi are tinged with fulvous; apical spur of hind tibiæ and its basal area black.

Posterior face of the metathorax dull, very faintly striated, divided by a median carina into two areas which are enclosed by a ridge with a protruding blunt angle on each side. Abdomen elongate, first segment short but about as wide as the second; the transverse groove appears to be the offset of a carina. The black areas on the upper part of the abdominal segments, and the dorsum of thorax where not rubbed, apparently owe much of their subopaqueness to a fine pollinose coating. Wings dusky, tinged with brown along fore margin, and clouded apically.

Length, 8.5 mm.; wing, 7 mm.

Symmorphus walshianus Sauss. Kansas, Lawrence; June. New to the Kansas list.

Monobia quadridens L. Kansas, Lawrence; July; August.

Family CHRYSIDIDÆ.

Chrysis pattoni Aaron. Colorado, Colorado Springs; August.
Hedychrum obsoletum Say. Colorado, Denver; August.
violaceum Brulle. Colorado, Colorado Springs; August.

Family BETHYLIDÆ.

Epyris armifera Say. Kansas, Lawrence; July. New to the Kansas list.

Family MYZINIDÆ.

Myzine sexcincta Fab. Kansas, Lawrence; September. Wichita; August; September.

Family SCOLIIDÆ.

Elis plumipes Drury. Kansas, Lawrence; July.

Family TIPHIIDÆ.

Tiphia inornata Say. Kansas, Lawrence; June.
tarda Say. Kansas, Lawrence; June; July. New to the Kansas list.

Family MYRMOSIDÆ.

Myrmosa unicolor Say. Kansas, Lawrence; July.

Family MUTILLIDÆ.

?Mutilla ornativentris Cr. Kansas, Lawrence; August.
Timulla californica Rad. Colorado, Colorado Springs; August.
Sphærophthalma creusa Cr. Colorado, Colorado Springs, August.
quadriguttata Say. Kansas, Wichita; August.
sparsa Fox. Kansas, Lawrence; May. New to the Kansas list.
vesta Cr. Colorado, Colorado Springs; August.

Family PONERIDÆ.

(In this and the following three families the determinations of species and forms were made by comparison with specimens that have been identified by Prof. W. M. Wheeler, or in cases where this course was not possible, the specimens received his personal attention.)

Proceratium croceum Roger. Kansas, Lawrence; August, a single male specimen; "probably this species," according to Prof. W. M. Wheeler, who further remarked: "This is an extremely rare ant—with the exception of a male of *P. crassicorne* in my collection, the only known male of this interesting genus. The workers are yellow and live in small colonies in rotten wood in rich forests." New to the Kansas list.

Family MYRMICIDÆ.

Cremastogaster lineolata Say. Kansas, Lawrence; April, females and workers; June, worker; September, male and females. New to the Kansas list.
lineolata Say, subspecies læviuscula Mayr. Kansas, Lawrence; October, workers under bark of old dead elm. Wichita; April, workers. New to the Kansas list.
Solenopsis molesta Say, (=debilis Mayr.). Kansas, Lawrence; July, females and workers; August, male. New to the Kansas list. Colorado, Denver; August, females.
texana Emery. Kansas, Lawrence; June, twilight, female. New to the Kansas list.

Myrmecina graminicola Forster, subspecies americana Mayr. Kansas, Lawrence; September and October, males. New to the Kansas list.

Monomorium minutum Mayr., var. minimum Buckley. Kansas, Lawrence; July, and July, twilight, workers. New to the Kansas list.

Myrmica rubra Linne. Kansas, Lawrence; September. New to the Kansas list.

rubra Linne, subspecies brevinodis Emery, variety. Colorado, Colorado Springs; April. Professor Wheeler referred to the specimen as follows: "It seems to be an undersized or microgyne female."

Stenamma (Aphænogaster) tennesseense Mayr. Kansas, Lawrence; May, worker. New to the Kansas list.

Pogonomyrmex occidentalis Cresson. Colorado, Colorado Springs; April, workers.

Family DOLICHODERIDÆ.

Dorymyrmex pyramicus Roger. Colorado, Colorado Springs; August, males and workers.

Iridiomyrmex analis Andre, variety. Kansas, Lawrence; July, worker. New to the Kansas list.

Family FORMICIDÆ.

Camponotus castaneus Latreille, subspecies americanus Mayr. Kansas. New to the Kansas list.

herculaneus Linne, subspecies pennsylvanicus De Geer. Kansas, Lawrence; April, worker; July, females attended by workers emerging from sills of a house, and female in flight; July, at night, males; June, twilight, also July, and July, twilight, minor workers.

marginatus Latreille, var. minutus Emery. Kansas, Lawrence; July, twilight, worker; October, workers. New to the Kansas list.

marginatus Latreille, var. nearcticus Emery. Kansas, Lawrence; June, female. New to the Kansas list.

Prenolepis (Nylanderia) imparis Say. Kansas, Lawrence; March and April, males. New to the Kansas list.

Lasius interjectus Mayr. Kansas, Lawrence; April, workers. New to the Kansas list.

niger Linne, var. americanus Emery. Kansas, Lawrence; March, female; April, male and female; July, and July, twilight, and September, at night, males. New to the Kansas list.

niger Linne, var. neoniger Emery. Colorado, Denver; August, males, females and workers issuing from cracks in slab stone walk.

umbratus Nylander, variety. Kansas, Lawrence; June, female. New to the Kansas list.

Formica fusca Linne, var. argentata Wheeler. Colorado, Colorado Springs; April and August, workers. Denver; August, workers.

fusca Linne, var. neoclara Emery. Colorado, Colorado Springs; April, workers. Denver; August, workers.

fusca Linne, var. subsericea Say. Kansas, Lawrence; July, male. New to the Kansas list. Colorado, Denver; August, males.

Formica fusca Linne, subspecies subpolita Mayr. Kansas, Lawrence; July, female. New to the Kansas list.

schaufussi Mayr. Kansas, Lawrence; July, female. New to the Kansas list.

Family PELECINIDÆ.

Pelecinus polyturator Drury. Kansas, Lawrence; July; August. Colorado, Denver; August.

Family PROCTOTRYPIDÆ.

Proctotrypes belfragei Ash. Kansas, Lawrence; November. New to the Kansas list.

caudatus Say. Kansas, Lawrence; October.

pallidus Say. Kansas, Lawrence; August.

terminalis Ash. Kansas, Lawrence; June. New to the Kansas list.

Family BELYTIDÆ.

Zelotypa texana Ash. Kansas, Lawrence; April. New to the Kansas list.

Pantoclis analis Ash. Kansas, Lawrence; July. New to the Kansas list.

Family DIAPRIIDÆ.

Spilomicrus atropetiolatus Ash. Colorado, Denver; August.

Family SCELIONIDÆ.

Prosacantha punctiventris Ash. Kansas, Lawrence; April. New to the Kansas list.

Family FIGITIDÆ.

Aspicera albihirta Ash. Kansas, Lawrence; June, twilight, and at night. New to the Kansas list.

Family CHALCIDIDÆ.

Chalcis flavipes Fab. (=ovata Say). Kansas, Lawrence; November.

Spilochalcis torvina Cr. Kansas, Lawrence; October. Colorado, Colorado Springs; August.

Haltichella onatas Wk. Kansas, Lawrence. (Name erroneously spelled *ovatus* in Trans. Kan. Acad. Sci., vol. XXI, pt. I, p. 160, where an account is given of the breeding of the species from section of elm tree infested by *Magdalis armicollis* Say. Specimen emerged in May, 1905, from section of tree kept in breeding-cage since the preceding September.) Determined by Dr. W. H. Ashmead. New to the Kansas list.

Family EURYTOMIDÆ.

Eurytoma crassineura Ash. Colorado, Colorado Springs; August.

magdalidis Ash. Colorado, Colorado Springs; August.

Family PERILAMPIDÆ.

Perilampus platygaster Say. Kansas, Wichita; September, by sweeping in vineyard. Colorado, Colorado Springs; August.

Family EUCHARIDÆ.

Orasema coloradensis Ash. Kansas, Lawrence; August, twilight. New to the Kansas list.

Family ICHNEUMONIDÆ.

Obba (Ichneumon) orpheus Cr. Colorado, Denver; August.

Ichneumon animosus Cr., var. rubellus Cr. Colorado, Colorado Springs; August.

grotei Cr. Colorado, Denver; August.

pedalis Cr. Colorado, Denver; August, including color varieties either with black or reddish tarsi of posterior legs.

Cratichneumon azotus Cr. Colorado, Denver; August.

extrematatis Cr. Kansas, Lawrence; May; October. New to the Kansas list.

Barichneumon paratus Say. Kansas, Lawrence; July, twilight.

Stiboscopus oryxicornis Vr. Kansas, Lawrence; July (type and homotype); July, twilight. Addition to the Kansas list.

Diaglypta manitouensis Vr. Colorado, Manitou 6629 feet; August (type).

Pezomachus alogus Vr. Kansas, Lawrence; May, at electric light (type). Addition to the Kansas list.

Cryptus albitarsus Cr. Kansas, Lawrence; May, at night. New to the Kansas list.

Lampronota amphimilæna Walsh. Colorado, Denver; August.

pleuralis Cr. Colorado, Colorado Springs; August.

Harrimaniella pæneimitatrix Vr. Kansas, Lawrence; October (metatype); October and November (homo-topotypes). Addition to the Kansas list.

Thalessa lunator Fab. Kansas, Lawrence; May, a small-sized female hovering around a partly dead soft maple tree; males and females on dying box-elder, the females ovipositing.

Ephialtes pygmæus Walsh. Kansas, Lawrence; October. New to the Kansas list.

Pimpla annulipes Br. Kansas, Lawrence; April; May; June; August; August, at night; October.

conquisitor Say. Kansas, Lawrence; October.

inquisitor Say. Kansas, Lawrence; May. New to the Kansas list. Colorado, Denver and Colorado Springs; August.

parvialba Vr. Kansas, Lawrence; June, twilight (type). Addition to the Kansas list.

Glypta aprilis Br. Kansas, Lawrence; April 23, 1892 (type). Addition to the Kansas list.

Callidiotes kansensis Brues. Kansas, Lawrence; July, twilight (type). Addition to the Kansas list.

Scopiorus monticola Brues. Colorado, Colorado Springs; August (type).

Sychoportus tuckeri Vr. Kansas, Lawrence; August (type); May, at night (metatype). Addition to the Kansas list.

Bassus lætatarius Fab. Kansas, Lawrence; June; June, twilight.

Syrphoctonus maculifrons Cr. Colorado, Denver and Colorado Springs; August.

Stenomacrus hastatus Davis. Colorado, Tabernash; August.

Metacœlus lævis Cr. Colorado, Colorado Springs; August.

Ophion bilineatum Say. Kansas, Lawrence; March; March, at night; April; May; May, at night, and at electric light; June; August.

idoneum Vr. Kansas, Lawrence; April (metatype); March; April, at night; May; May, at night (homo-topotypes). Addition to the Kansas list.

Ophion purgatum Say. Kansas, Lawrence; June; June, at night; July, twilight. Colorado, Colorado Springs; August.

Campoplex villosus Norton. Kansas, Lawrence; data missing. New to the Kansas list.

Amorphota augusta Vr. Kansas, Lawrence; August (type and homo-paratype). Addition to the Kansas list.

nocturna Vr. Kansas, Lawrence; May, at night (type). Addition to the Kansas list.

pænexareolata Vr. Kansas, Lawrence; August (type); June; June, twilight; July; August (homo-topotypes). Addition to the Kansas list.

perrivalis Vr. Kansas, Lawrence; August (types); May and July (paratypes); June, twilight. Addition to the Kansas list. Colorado, Denver; August.

Angitia autumnalis Vr. Kansas, Lawrence; September (type). Addition to the Kansas list.

Idechthis biconjugatus Vr. Kansas, Lawrence; May, at night (type). Addition to the Kansas list.

Ischnoscopus tæniatus Vr. Kansas, Lawrence; July (type). Addition to the Kansas list.

Limneria flavicincta Ash. Colorado, Denver; August.

lawrencei Vr. Kansas, Lawrence; May, at night (type). Wichita; April (homotypes). Addition to the Kansas list.

perdistincta Vr. Kansas, Lawrence; August (type); April, at night; August (metatypes); June, twilight, and at night; July; August; August, twilight (homo-topotypes). Wichita, September (homotype). Addition to the Kansas list. Colorado, Denver; March, in window; April, commonly taken by sweep-in grass; August, scarce.

tibiator Cr., var. Colorado, Denver and Colorado Springs; August.

virgilis Vr. Kansas, Lawrence; May, at night (type). Addition to the Kansas list.

Paniscus geminatus Say. Kansas, Lawrence; April, at night; May, at night; June; July, at night. Wichita; May.

Ceratosoma fasciata Cr. Kansas, Lawrence; August. New to the Kansas list.

Mesochrus noctivagus Vr. Kansas, Lawrence; May, at night (type). Addition to the Kansas list.

Porizon canaliculatus Vr. Colorado, Tabernash; August.

Thersilochus mimeticus Vr. Kansas, Wichita; September, 1895, in vineyard (type). Addition to the Kansas list.

quintilis Vr. Kansas, Lawrence; July (type). Addition to the Kansas list.

Pristomerus appalachianus Vr. Kansas, Wichita; September, 1895, in vineyard (male type). Addition to the Kansas list.

appalachianus Vr., var. dorsocastaneous Vr. Kansas, Lawrence; August (male and female types and homo-topotype). Addition to the Kansas list.

Family ALYSIIDÆ.

Œnonogastra microrhopalæ Ash. Kansas, Lawrence; July, twilight. New to the Kansas list.

Aphæreta delosa Vr. Kansas, Lawrence; August (cotypes, paratype and homo-topotypes); June, twilight; August, twilight (metatypes); July, twilight. Addition to the Kansas list.

subtricarinata Vr. Kansas, Lawrence; August (type); May, at night (paratype). Addition to the Kansas list.

Dinotrema signifrons Vr. Kansas, Lawrence; June, at night (type). Addition to the Kansas list.

Aspilota columbiana Vr. Kansas, Lawrence; August (type). Addition to the Kansas list.

Family BRACONIDÆ.

Lysiphlebus succineus Vr. Kansas, Lawrence; August (type). Addition to the Kansas list.

Meteorus noctivagus Vr. Kansas, Lawrence; May, at night (type). Addition to the Kansas list.

relativus Vr. Kansas, Lawrence; September, 1902, appearing in breeding-cage containing both larvæ and pupæ of *Malacosoma disstria* Hubn. (type and homo-topotypes). Addition to the Kansas list.

Macrocentrus atriceps Cr. Kansas, Lawrence; August. New to the Kansas list.

delicatus Cr. Kansas, Lawrence; August. New to the Kansas list.

Zele crassicalcaratus Vr. Kansas, Lawrence; August (type and homo-topotype); May; July; July, twilight (homo-topotypes). Addition to the Kansas list.

Cenocœlius politifrons Vr. Kansas, Lawrence; June, 1892, collected in timber along Kansas river (type). Addition to the Kansas list.

Brachistes nocturnus Vr. Kansas, Lawrence; May, at night (type). Addition to the Kansas list.

Calyptus (Brachistes) rotundiceps Cr. Kansas, Lawrence; September 26, 1904, in company with *Melanobracon ulmicola* Vr. (see notes quoted after this name). Other specimens emerged during the following spring from April 13 to May 24, from sections of elm tree kept in breeding-cage. New to the Kansas list.

Chelonus sericeus Say. Colorado, Colorado Springs; August.

texanus Cr. Kansas, Wichita; September, 1895, on farm near city, and taken by sweeping in slough-grass in timber along Arkansas river. New to the Kansas list.

Agathis media Cr. Kansas, Wichita; September. New to the Kansas list. Colorado, Garden of the Gods, near Colorado City; July. Colorado Springs; August.

vulgaris Cr. Colorado, Colorado Springs; July and August.

Crassomicrodus divisus Cr. Kansas, Wichita; September, 1895, in vineyard. New to the Kansas list.

fulvescens Cr. Colorado, Colorado Springs; August.

medius Cr. Colorado, Colorado Springs; August.

nigricaudus Vr. Colorado, Colorado Springs; August (typ , paratype and homo-topotypes).

Microdus castaneicinctus Vr. Kansas, Lawrence; August (type). Addition to the Kansas list.

pimploides Vr. Kansas, Lawrence; August (type and homo-topotype); September (homo-topotype). Addition to the Kansas list.

wichitaensis Vr. Kansas, Wichita; September, 1895, in vineyard (type and homo-topotype). Addition to the Kansas list.

Cardiochiles explorator Say. Colorado, Colorado Springs; August.

Apanteles congregatus Say. Kansas, Lawrence; June, bred from unknown host on blade of grass. New to the Kansas list.

congregatus Say, var. hemileucæ Riley. Kansas, Lawrence; November, bred from cocoon mass on willow leaf. New to the Kansas list.

ensiger Say. Kansas, Lawrence; July, twilight. New to the Kansas list.

xylina Say. Kansas, Lawrence; August. New to the Kansas list.

Pseudapanteles bisstigmata Say. Kansas, Lawrence; August. New to the Kansas list.

Microgaster tuckeri Vr. Kansas, Lawrence; June (type). Addition to the Kansas list.

Microplitis croceipes Cr. Kansas, Wichita; September, 1895, swept from peanut vines. New to the Kansas list.

Biosteres indotatus Vr. Kansas, Lawrence; August (type and homo-topotypes). Addition to the Kansas list.

Diachasma appalachicola Vr. Kansas, Lawrence; July (type). Addition to the Kansas list.

secunda Vr. Kansas, Lawrence; July (type). Addition to the Kansas list.

Opius aberrans Vr. Kansas, Lawrence; August (type, paratype and homo-topotypes). Addition to the Kansas list.

basiniger Vr. Kansas, Lawrence; July (type); June, twilight (metatype). Addition to the Kansas list.

luteiceps Vr. Kansas, Lawrence; August (type). Addition to the Kansas list.

nigrocastaneus Vr. Kansas, Lawrence; July (type). August, twilight (metatype); July (homo-topotype, having dorsum of thorax wholly brownish between parapsidal grooves). Addition to the Kansas list.

Iphiaulax rugator Say. Kansas, Lawrence; August. New to the Kansas list.

Melanobracon ulmicola Vr. Kansas, Lawrence.

Notes concerning the capture of this species were published in Trans. Kan. Acad. Sci., vol. XXI, pt. I, p. 160, to this effect: "Males and females flying about and alighting on bark of infested portions of elm tree later cut into sections for breeding purposes, September 26, 1904, the female probing with the ovipositor into the cracks of the bark and holes of *Magdalis armicollis* Say, whose larvæ abounded beneath the bark; other specimens emerged during the following May from sections of the tree kept in breeding-cage. Regarding the naming of these parasites, Mr. H. L. Viereck, to whom a pair of specimens was

submitted for study, wrote as follows: 'This appears to be a new species and one that has been confused with *simplex*. I propose to call it *ulmicola*.'" Further captures were made at random in May. (Metatype and homo-topotypes.) Addition to the Kansas list.

Microbracon sulcifrons Ash. Colorado, Colorado Springs; August.

Bracon kansensis Vr. Kansas, Wichita; September, 1895, in vineyard (type). Addition to the Kansas list.

piceiceps Vr. Kansas, Lawrence; data missing (type). Addition to the Kansas list.

millitor Say, var. xanthostigma Cr. Kansas, Lawrence; April; August. Colorado, Colorado Springs; August.

Rhogas intermedius Cr. Kansas, Lawrence; May, at night; August. Also a variety taken in July and August. Colorado, Colorado Springs; August.

melanothorax Vr. Kansas, Lawrence; August (type). Addition to the Kansas list.

terminalis Cr. Kansas, Lawrence; May, at electric light, and at night; June, twilight, and at electric light; July, at electric light; October.

Hedysomus wichitus Vr. Kansas, Lawrence; August, twilight (type). Addition to the Kansas list.

Hormiopterus claripennis Brues. Kansas, Lawrence; September (type). Addition to the Kansas list.

Phænodus caddous Vr. Kansas, Lawrence; June, twilight (type). Addition to the Kansas list.

Spathius simillimus Ash. Kansas, Lawrence; associated with *Melanobracon ulmicola* Vr. (see reference and notes after this name); specimens emerged April 3 to May 29, 1905, from sections of elm tree kept in breeding-cage. Doctor Ashmead, who determined the species, added the following remark: "All *Spathius* are parasitic on Coleoptera."

Family Siricidæ.

(Mr. H. L. Viereck, in reporting upon the Siricoidea and Tenthredinoidea submitted to him, acknowledges the assistance of Dr. A. D. MacGillivray.)

Sirex flavicornis Fab. Colorado, Manitou; July. Denver and Tabernash; August.

Paururus nigricornis Fab. Kansas, Lawrence; October. New to the Kansas list.

Tremex columba L. Kansas, Lawrence; September 24, 1904, one female found dead with ovipositor stuck fast in bark of elm tree; October. Colorado, Denver; August.

Family Cephidæ.

Cephus trimaculatus Say. Kansas, Lawrence; May. (Det. by H. E. Burke.) New to the Kansas list.

Family Xyelidæ.

Macroxyela ferruginea Say. Kansas, Lawrence; April.

Family Hylotomidæ.

Schizocera zabriskii Ash. Kansas, Lawrence; August. New to the Kansas list.

Hylotoma miniata Klug. Kansas, Lawrence; June. New to the Kansas list.

Family PTERYGOPHORIDÆ.

Acordulecera dorsalis Say. Kansas, Lawrence; June; June, twilight; July; July, twilight; August.

Family SELANDRIIDÆ.

Blennacampa pygmæa Say. Kansas, Lawrence; June. New to the Kansas list.

Endelomyia rosæ Har. Kansas, Lawrence; April; May, on rose bushes. New to the Kansas list.

Family NEMATIDÆ.

Gymnonychus appendiculatus Htg. Colorado, Colorado Springs; August.

Pteronus latus Mar. Kansas, Lawrence; May. New to the Kansas list.

mendicus Walsh. Colorado, Colorado Springs; August. (Personally determined by Dr. A. D. MacGillivray.)

Family TENTHREDINIDÆ.

Dolerus aprilis Nor. Kansas, Lawrence; May.

bicolor Bvr. Kansas, Lawrence; April.

Emphytus apertus Nor. Kansas, Lawrence; August. New to the Kansas list.

Macrophya tibiator Nor. Kansas, Lawrence; April.

Tenthredo variegata Nor. Kansas, Lawrence; May. New to the Kansas list.

Family CIMBICIDÆ.

Zarea americana Cr. Kansas, Lawrence; April.

TABULATED SUMMARY OF FAMILIES AND SPECIES, INCLUDING VARIETIES.

NAME OF FAMILY.	Total number of species.	Species taken in Kansas.	Species new to Kansas.	Species taken in Colorado.	Species taken in both Kansas and Colorado.
Apidæ	1	1	.....	1	1
Bombidæ	12	5	.....	8	1
Anthophoridæ	12	3	.....	9	.....
Nomadidæ	4	3	1	1	.....
Ceratinidæ	1	1	.....	.....	.....
Megachilidæ	11	2	1	9	.....
Stelidæ	3	.....	.....	3	.....
Panurgidæ	5	1	.....	4	.....
Andrenidæ	17	11	6	8	2
Oxybelidæ	1	1	.....	.....	.....
Crabronidæ	5	4	4	1	.....
Pemphredonidæ	7	5	4	2	.....
Bembecidæ	3	3	.....	1	1
Larridæ	4	2	1	2	.....
Philanthidæ	5	3	.....	2	.....
Trypoxylidæ	5	4	2	1	.....
Mellinidæ	2	1	.....	1	.....
Nyssonidæ	1	1	.....	.....	.....
Stizidæ	1	1	.....	.....	.....
Sphecidæ	17	9	3	8	.....
Ceropalidæ	12	8	3	6	2
Vespidæ	9	5	1	5	1
Eumenidæ	16	12	6	5	1
Chrysididæ	3	.....	.....	3	.....
Bethylidæ	1	1	1	.....	.....
Myzinidæ	1	1	.....	.....	.....
Scoliidæ	1	1	.....	.....	.....
Tiphiidæ	2	2	1	.....	.....
Myrmosidæ	1	1	.....	.....	.....
Mutillidæ	6	3	1	3	.....
Poneridæ	1	1	1	.....	.....
Myrmicidæ	10	8	8	3	1
Dolichoderidæ	2	1	1	1	.....
Formicidæ	14	11	10	4	1
Pelecinidæ	1	1	.....	.....	.....
Proctotrypidæ	4	4	2	.....	.....
Belytidæ	2	2	2	.....	.....
Diapriidæ	1	.....	.....	1	.....
Scelionidæ	1	1	1	.....	.....
Figitidæ	1	1	1	.....	.....
Chalcididæ	3	3	1	1	1
Eurytomidæ	2	.....	.....	2	.....
Perilampidæ	1	1	.....	1	1
Eucharidæ	1	1	1	.....	.....
Ichneumonidæ	52	37	29	19	4
Alysiidæ	5	5	5	.....	.....
Braconidæ	48	41	37	10	3
Siricidæ	3	2	1	2	1
Cephidæ	1	1	1	.....	.....
Xyelidæ	1	1	.....	.....	.....
Hylotomidæ	2	2	2	.....	.....
Pterygophoridæ	1	1	.....	.....	.....
Selandriidæ	2	2	2	.....	.....
Nematidæ	3	1	1	2	.....
Tenthredinidæ	5	5	2	.....	.....
Cimbicidæ	1	1	.....	.....	.....
Totals (56 families)	337	229	143	129	21

LIST OF DIPTERA.

Attention is called to the tabulated summary which appears at the end of this list and gives a comparative disposal of the number of species with reference to families. The names of thirty-six species are reported as new to the Kansas lists. This number includes ten new species in the following families: Chironomidæ, five named and described by O. A. Johannsen (not counting a change of name); Cecidomyiidæ, three by E. P. Felt (MS. names); Asilidæ, one by J. S. Hine; and Helomyzidæ, one by myself (description herewith incorporated). From the Colorado material, one new species in the family Trypetidæ has been described by E. T. Cresson, jr., and two new species in the family Oscinidæ are based upon my own descriptions.

Through the courtesy of Dr. L. O. Howard, chief of the Bureau of Entomology, United States Department of Agriculture, Washington, D. C., I have been afforded the very helpful services of Mr. D. W. Coquillett in the identification of several species. Mr. E. T. Cresson, jr., has also helped me through difficulties attending the determination of species in the families Muscidæ, Borboridæ, Ortalidæ, Trypetidæ, and Ephydridæ. Other acknowledgments of assistance are made in the proper places.

The plan of systematic arrangement herein employed is the same as was used in my previous paper treating of the Diptera.

Family TIPULIDÆ.

(Valuable aid in the identification of species in this family has been generously rendered by Mr. R. W. Doane.)

Rhipidia domestica O. S. Kansas, Lawrence; September, at night. New to the Kansas list.

Dicranomyia duplicata Doane. Colorado, Colorado Springs; August.

Dicranoptycha sobrina O. S. Kansas, Lawrence; June.

Erioptera caloptera Say. Kansas, Lawrence; May. New to the Kansas list.

septemtrionalis O. S. Kansas, Lawrence; August. New to the Kansas list.

Helobia hybrida Meig. Kansas, Lawrence; October. Colorado, Denver; April, swept from grass on lawn.

Gnophomyia tristissima O. S. Kansas, Lawrence; May.

Trichocera bimacula Wk. Kansas, Lawrence; January 2, 1907, a mild (temp. 51°), damp and cloudy day which occasioned the appearance of swarms of these flies hovering in the air. New to the Kansas list.

Pachyrhina incurva Lw. Kansas, Lawrence; June, twilight. New to the Kansas list.

macrocera Lw. Kansas, Lawrence; May. New to the Kansas list.

polymera Lw. Kansas, Lawrence; June. New to the Kansas list.

Tipula angustipennis Lw. Colorado, Denver; April.

bella Lw. Kansas, Lawrence; July; September. New to the Kansas list.

bicornis Lw. Kansas, Lawrence; May. New to the Kansas list.

inermis Doane. Kansas, Lawrence; May, at night, and attracted by light in house; June, at night. New to the Kansas list.

Family CHIRONOMIDÆ.

(Prof. O. A. Johannsen has not only given great help in the specific determinations, but has named and described new species from specimens collected by me. His system of arrangement and nomenclature is followed.)

Culicoides (Ceratopogon) guttipennis Coq. Kansas, Lawrence; May. This name determined as "probably, specimen defective." New to the Kansas list.

Bezzia elegantula Joh. (Described in K. U. Sci. Bull., vol. IV, p. 109.) Kansas, Lawrence; July, at electric light on bridge across Kansas river (type). Addition to the Kansas list.

Tanypus (Ablabesmyia) aureus Joh. (K. U. Sci. Bull., vol. IV, p. 110.) Kansas, Lawrence; July, at electric light on bridge across Kansas river (type). Addition to the Kansas list.

monilis L. Kansas, Lawrence; July, at electric light on Kansas river bridge.

Chironomus aberrans Joh. Kansas, Lawrence; July. New to the Kansas list.

flaviventris Joh. (K. U. Sci. Bull., vol. IV, p. 111.) Kansas, Lawrence; July, at electric light on bridge across Kansas river (types). Addition to the Kansas list.

halteralis Coq. Kansas, Lawrence; April, at night.

lucifer Joh. (K. U. Sci. Bull., vol. IV, p. 110.) Kansas, Lawrence; July, taken at electric light on bridge across Kansas river (types). Addition to the Kansas list.

needhamii Joh. (N. Y. State Mus. Bull., 124, p. 278). New name for species listed as *C. scalænus* Schrank, var., in Trans. Kan. Acad. Sci., vol. XX, pt. II, p. 197, and in K U. Sci. Bull., vol. IV, p. 86. Being merely a change of names, no addition is made to the Kansas list. Kansas, Lawrence; June, twilight (metatype).

nigricans Joh. Colorado, Denver; August.

riparius Meig. "Defective specimen, but probably this species," according to Professor Johannsen. Colorado, Tabernash; August.

similis Joh. Professor Johannsen reported on this as "Defective specimen, may be same as *similis*." Colorado, Tabernash; August.

Camptocladius (Chironomus) aterrimus Meig. Kansas, Lawrence; July, twilight. New to the Kansas list.

Psectrocladius aureus Joh. (N. Y. State Mus. Bull., 124, p. 283.) Kansas, Lawrence; July (type). Addition to the Kansas list.

Metriocnemus exagitans Joh. (K. U. Sci. Bull., vol. IV, p. 112.) Kansas, Lawrence; March; April; April, at night (metatypes). New to the Kansas list.

Tanytarsus obediens Joh. Colorado, Colorado Springs; August.

Family MYCETOPHILIDÆ.

Macrocera inconcinna Lw. Colorado, Tabernash; August.

Family CECIDOMYIIDÆ.

Lestremia kansensis Felt, n. sp. Kansas, Lawrence; May. Addition to the Kansas list.

leucophæa Meig. Kansas, Lawrence; August. (Det. by O. A. Johannsen.) New to the Kansas list.

vernalis Felt, n. sp. Kansas, Wichita, April. Addition to the Kansas list.

Porricondyla tuckeri Felt, n. sp. Kansas, Lawrence; August. Addition to the Kansas list.

Family BIBIONIDÆ.

Bibio albipennis Say. Kansas, Lawrence; May. (A single female specimen determined by W. A. Hooker.)

Family THEREVIDÆ.

Psilocephala aldrichi Coq. Colorado, Denver; August.

Family ASILIDÆ.

Erax varipes Will. Colorado, Denver; August. (Det. by J. S. Hine.)

Philonicus rufipennis Hine. (Ohio Nat., vol. VII, p. 117.) Kansas, Lawrence; May and June (cotypes.) Addition to the Kansas list.

Family EMPIDIDÆ.

Tachydromia inusta Mel. Colorado, Manitou; August. The following remarks by Prof. A. L. Melander, who identified the specimens mentioned in K. U. Sci. Bull., vol. IV, p. 96, precludes any further question concerning the determination: "I have carefully compared the specimens of *Tachypeza* (*Tachydromia*) *inusta* with the type series. Your specimens are remarkably constant in their light color, but in the absence of any definite characters otherwise, I hardly think them to be a new species. *T. inusta* is a common species further west, and may extend into Colorado. Their cave habits may explain their lighter color."

Rhamphomyia irregularis Lw. Kansas, Wichita; April.

masoni Coq. Kansas, Lawrence; May, at night.

Family SYRPHIDÆ.

Melanostoma mellinum L. Kansas, Lawrence; June, twilight.

Family TACHINIDÆ.

Schizotachina convecta Wk. Colorado, Colorado Springs; August.

Celatoria spinosa Coq. Colorado, Manitou; July.

Tachina rustica Fal. Colorado, Colorado Springs; August.

Family SARCOPHAGIDÆ.

Sarcophaga ægra Wk. Kansas, Lawrence; July. New to the Kansas list.

georgina Wd. Colorado, Denver; April. Colorado Springs; August. Tabernash and Buffalo; August.

Sorcophaga sarraceniæ Riley. Kansas, Lawrence; June; June, twilight; July; July, twilight. Wichita; August. Colorado, Denver; August.

Helicobia (Sarcophaga) helicis Towns. Kansas, Lawrence; July, twilight.
quadrisetosa Coq. Kansas, Lawrence; June; July; July, twilight. New to the Kansas list.

Family MUSCIDÆ.

Cynomyia cadaverina Desv. Kansas, Lawrence; April; October. Colorado, Tabernash; August.

Calliphora coloradensis Hough. Kansas, Lawrence; April. New to the Kansas list.

Lucilia cæsar L. Kansas, Lawrence; May.

Muscina stabulans Fal. Kansas, Lawrence; May.

Family ANTHOMYIDÆ

Ophyra leucostoma Wd. Kansas, Lawrence; July, twilight; August. Colorado, Denver and Colorado Springs, August.

Homalomyia canicularis L. Kansas, Lawrence; July. New to the Kansas list. Colorado, Denver and Colorado Springs; August, numbers hovering in shade of trees.
scalaris Fab. Kansas, Lawrence; May; May, twilight; June; June, twilight; July. Wichita; April. New to the Kansas list. Colorado, Colorado Springs; August.

Hyetodesia lucorum Fal. Colorado, Tabernash; August.

Spilogaster (Hyetodesia) nigripennis Wk. Colorado, Tabernash; August.

Anthomyia albicincta Fal. Colorado, Colorado Springs; July and August.
radicum L. Colorado, Denver; August.

Phorbia fusciceps Zett. Colorado, Colorado Springs, Denver, and Tabernash; August.

Cœnosia flavicoxa Stein. Kansas, Lawrence; April; May; July. Wichita; April. New to the Kansas list. Colorado, Manitou; July. Colorado Springs; July and August. Denver; August.
lata Wk., (=canescens Stein). Kansas, Wichita; September.

Family SCATOPHAGIDÆ.

Scatophaga furcata Say. Kansas, Lawrence; May. Colorado, Tabernash; August.

Family HELOMYZIDÆ.

Helomyza nemorum Meig. Colorado. (Det. by Aldrich and Darlington.)

Anorostoma marginata Lw. Colorado, Tabernash; August. (Det. by Aldrich and Darlington.)

Œcothea fenestralis Fal. Kansas, Lawrence; May. (Det. by Aldrich and Darlington.) New to the Kansas list.

Leria caccabata, n. sp. Kansas, Lawrence; May. Addition to the Kansas list. Type: one male specimen deposited in the United States National Museum.

General color chocolate black. Occiput and ocellar triangle black; orbital margins of front grayish; front broad, orange colored; lower portions of head brownish, except infuscated tip of proboscis. First and second antennal joints brownish; third joint infuscated, enlarged oval, with black arista as long as height of head, and minutely pubescent.

Sparse black but rather coarse pubescence covers the occiput, front and lower half of cheeks, from which it spreads backward; second joint of antennæ scantily pubescent above and bearing a distinct bristle; ocellar bristles long, curved forward in a pair; two occipito-orbital and two marginal front bristles stout and reversely curved, arising from black dots; vibrissa single. Eyes nearly round, reddish, vertical diameter exceeding the width of cheeks by one-half the distance.

Scutellum bare, entirely grayish sericeous, bearing the usual bristles. Dorsum of thorax, the abdomen and the legs are clothed with black pubescence which is longer on the anterior femora and strongly fringes the fore and middle coxæ. A pair of grayish or inclined to brownish sericeous vittæ extends medially on dorsum, and similarly colored effects are also shown latterally under different lights. Dorsal bristles arise from black dots. Mesopleura and pteropleura wholly bare; sternopleura with four black bristles in a row close to the upper edge, the posterior bristle being twice the length of the anterior one, and the two middle ones range in length between; the median space of the sternum is covered with long black hairs.

Lateral margins of abdomen beyond first segment, and distal margins of all segments, brown, the fourth being scarcely infuscated; hypopygium full rounded, dark brownish. Coxæ, trochanters and tips of all the femora dark brownish; tibiæ and tarsi inclined to fuscous brown. Halteres brownish.

Wings hyaline, except yellowish subcostal cell, which is narrow, veins dark or fuscous brown; costal spines black, rather widely spaced; second and third veins slightly approximated, but apically divergent.

Length, 6 mm.; wing, 5.5 mm.

Near *iners* Meigen, but lacks hairs on the mesopleura, while the third antennal joint is fuscous and color of abdomen is variegated; besides, the tarsal joints of fore legs are not flattened and the spurs of the middle tibiæ are almost straight. The bristles of the sternopleura are too distinct to be classed as hairs, hence this specimen could not be placed with *crassipes* Loew, from which it differs in other features.

Family Borboridæ.

Borborus equinus Fal. Kansas, Lawrence; June, twilight. Colorado, Tabernash; August.

geniculatus Macq. Colorado, Tabernash; August.

Sphærocera subsultans Fab. The same as cited by F. H. Snow, in K. U. Sci. Bull., vol. II, No. 5, p. 220, as *S. coprophagus*, a manuscript name attributed to Dr. S. W. Williston. Kansas, Lawrence; July.

Family Sciomyzidæ.

Sciomyza humilis Lw. Colorado, Colorado Springs; August.

obtusa Fal. Colorado, Tabernash; August.

Family Sapromyzidæ.

Sapromyza connexa Say. Colorado, Denver; August.

innuba Giglio-Tos. Kansas, Lawrence; September.

Family Ortalidæ.

Chrysomyza demandata Fab. Kansas, Lawrence; October. New to the Kansas list.

Family TRYPETIDÆ.

Tephritis genalis Thom. Colorado, Bear Creek canyon and Garden of the Gods, near Colorado City; July. Colorado Springs, August.
inornata Coq. Colorado, Bear Creek canyon, near Colorado City; July.
pallidipennis Cress. (Trans. Amer. Ent. Soc., vol. XXXIII, p. 104.) Colorado, Manitou; July (cotypes).
murina Doane. Colorado, Colorado Springs; August.
Euaresta araneosa Coq. Colorado, Colorado Springs; July and August. Cheyenne canyon and Garden of the Gods, near Colorado City; July. Green Mountain Falls; July.

Family EPHYDRIDÆ.

Paralimna appendiculata Lw. Colorado, Colorado Springs; August.
Hydrellia ischiaca Lw. Colorado, Colorado Springs; August.
Philygria fuscicornis Lw. Colorado, Colorado Springs; April.
Pilina truncatula Lw. Colorado, Tabernash; August.
Cænia bisetosa Coq. Colorado, Colorado Springs; August.

Family OSCINIDÆ.

Chlorops graminea Coq. Colorado, Tabernash; August. (Det. by C. F. Adams.)
Ectecephala albistylum Macq. Kansas, Lawrence; June; July, twilight. (Det. by C. F. Adams.) New to the Kansas list.
Oscinis flavescens Tkr. (Ent. News, vol. XIX, p. 272.) Colorado, Manitou, 6629 feet; August, 1894 (type).
nigra Tkr. (Ent. News, vol. XIX, p. 272.) Colorado, Denver; August, 1906 (type).
variabilis Lw. Colorado, Colorado Springs; August.

Family GEOMYZIDÆ.

Scyphella flava L. Colorado, Denver; August.

Family AGROMYZIDÆ.

Agromyza æneiventris Fal. Kansas, Lawrence; August. Colorado, Colorado Springs and Denver; August.
jucunda V. d. W. Colorado, Colorado Springs; August.
parvicornis Lw. Kansas, Lawrence; August.
Odinia ornata Zett. (Not cited in Aldrich's catalogue.) Kansas, Lawrence; July. New to the Kansas list.
Leucopis bella Lw. Colorado, Denver; August.

TABULATED SUMMARY OF FAMILIES AND SPECIES.

NAME OF FAMILY.	Total number of species.	Species taken in Kansas.	Species new to Kansas.	Species taken in Colorado.	Species taken in both Kansas and Colorado.
Tipulidæ	15	13	10	2	.....
Chironomidæ	16	12	9	4	.....
Mycetophilidæ	1	.....	.....	1	.....
Cecidomyiidæ	4	4	4	.....	.....
Bibionidæ	1	1	.....	.....	.....
Therevidæ	1	.....	.....	1	.....
Asilidæ	2	1	1	1	.....
Empididæ	3	2	.....	1	.....
Syrphidæ	1	1	1	.....	.....
Tachinidæ	3	.....	.....	3	.....
Sarcophagidæ	5	4	2	2	1
Muscidæ	4	4	1	1	1
Anthomyidæ	10	5	3	9	4
Scatophagidæ	1	1	.....	1	1
Helomyzidæ	4	2	2	2	.....
Borboridæ	3	2	.....	2	1
Sciomyzidæ	2	.....	.....	1	.....
Sapromyzidæ	2	1	.....	1	.....
Ortalidæ	1	1	1	.....	.....
Trypetidæ	5	.....	.....	5	.....
Ephydridæ	5	.....	.....	5	.....
Oscinidæ	5	1	1	4	.....
Geomyzidæ	1	.....	.....	1	.....
Agromyzidæ	5	3	1	3	1
Totals (24 families)	100	58	36	50	9

LIST OF HEMIPTERA.

Additional records are given for four species as follows, including one new addition to the Kansas list:

Family CAPSIDÆ.

Agalliastes apiatus Uhl. Colorado, Buffalo; August. (Det. by O. Heidemann.)

Family CORIXIDÆ.

Corixa alternata Say. Kansas, Lawrence; April, at electric light; May; May, at electric light. (Det. by O. Heidemann.) Wichita; August, at electric light.

Family JASSIDÆ.

Xestocephalus fulvocapitatus V. D. Kansas, Lawrence; August. New to the Kansas list.

pulicarius V. D. Kansas, Lawrence. The record of the month of capture following the name of this species listed in K. U. Sci. Bull., vol. IV, p. 66, should be changed from August to June.

NOTES UPON VARIATION OF MELISSODES LUPINA CRESSON.

By T. D. A. Cockerell, Las Vegas, N. M.

THREE male specimens of *Melissodes* collected by E. S. Tucker at Colorado Springs, Colo., during August, 1906, were submitted to me for examination.

The examples are so close to *Melissodes lupina* Cr. that I doubt whether they are more than a geographical race. Comparing them with a cotype of *M. lupina*, I find that the eyes of these specimens are bluer green and diverge less above, and the mesothorax is more shiny. A specimen from Raton, N. M., which I had labeled *lupina*, has the same color of the eyes and shiny mesothorax as in Mr. Tucker's insects, but the eyes diverge as in typical *lupina*. The color of the eyes is not quite satisfactory when examined only in dry specimens. On the whole, I should call these bees *M. lupina*, but they might be regarded as a distinct subspecies. Were it not for the Raton specimen being in some degree intermediate, I should not feel so undecided.

Mr. Tucker's insects, compared with cotype of *M aurigenia*, have the fourth antennal joint shorter and the pubescence different in color. Compared with cotype of *M. agilis*, these specimens have the face narrower (which may vary) and the apical plate of abdomen conspicuously broader.

SUPPLEMENTARY ADDITIONS TO THE LIST OF KANSAS DIPTERA.

By E. S. TUCKER, Bureau of Entomology, United States Department of Agriculture, Washington, D. C.

SINCE the publication of my previous list of additions to the recorded Diptera of Kansas, which appeared in Transactions of the Kansas Academy of Science, volume XX, part II, pages 197–201, 1906, further determinations of species remaining from my personal collections have been made, with the result that thirty-six specific names are hereby added to the Kansas list. For the purpose of convenient reference, these names are relisted separately from my accompanying paper entitled "Additional Results of Collecting Insects in Kansas and Colorado."

The specimens were collected at Lawrence, Kan., except in cases otherwise stated.

Family TIPULIDÆ.

Rhipidia domestica O. S. September, at night.
Erioptera caloptera Say. May.
septemtrionalis O. S. August.
Trichocera bimacula Wk. January 2, 1907, a mild (temp. 51°), damp and cloudy day, which occasioned the appearance of small swarms of these flies hovering in the air.
Pachyrhina incurva Lw. June, twilight.
macrocera Lw. May.
polymera Lw. June.
Tripula bella Lw. July; September.
bicornis Lw. May.
inermis Doane. May, at night, and attracted by light in house; June, at night.

Family CHIRONOMIDÆ.

Culicoides (Ceratopogon) guttipennis Coq. May.
Bezzia elegantula Joh. July, at electric light on bridge across Kansas river.
Tanypus (Ablabesmyia) aurea Joh. July, at electric light on bridge across Kansas river.
Chironomus aberrans Joh. July.
flaviventris Joh. July, at electric light on bridge across Kansas river.
lucifer Joh. July, at electric light on bridge crossing Kansas river.
needhamii Joh. New name for species formerly listed as *C. scalænus* Schrank, var. Being merely a change of names, no addition is made.
Camptocladius (Chironomus) aterrimus Meig. July, twilight.
Psectrocladius aureus Joh. July.
Metriocnemus exagitans Joh. March; April; April, at night.

Family CECIDOMYIIDÆ.

Lestremia kansensis Felt, n. sp. May.
leucophæa Meig. August.
vernalis Felt, n. sp. Wichita; April.
Porricondyla tuckeri Felt, n. sp. August.

Family ASILIDÆ.

Philonicus rufipennis Hine. May and June.

Family SYRPHIDÆ.

Melanostoma mellinum L. June, twilight.

SUPPLEMENTARY ADDITIONS TO THE LIST OF KANSAS HYMENOPTERA.

By E. S. TUCKER, Bureau of Entomology, United States Department of Agriculture, Washington, D. C.

FOR the sake of convenience in affording ready reference, a separate list of the specific names of Hymenoptera which I have reported as new to the Kansas lists is hereby offered. The records of localities and months of collection, together with other particulars concerning each species, will be found incorporated in my accompanying paper entitled "Additional Results of Collecting Insects in Kansas and Colorado," so that, in order to reduce duplication, these records are not repeated here.

Family NOMADIDÆ.

Epeolus compactus Cr.

Family MEGACHILIDÆ.

Megachile petulans Cr.

Family ANDRENIDÆ.

Halictus bruneri Cwfd.
macoupiensis Robt.
pilosus Sm.
sparsus Robt.
versatus Robt.
zephyrus Sm.

Family CRABRONIDÆ.

Paranothyreus cognatus Fox.
snowii Fox.
Stenocrabro tarsalis Fox.
Rhopalum rufigaster Pack.

Family PEMPHREDONIDÆ.

Passalœcus equalis Vr.
Diodontus brunneicornis Vr.
Mimesa argentifrons Cr.
unicincta Cr.

Family LARRIDÆ.

Tachytes obscurus Cr.

Family TRYPOXYLIDÆ.

Trypoxylon bidentatum Fox.
quintilis Vr.

Family SPHECIDÆ.

Isodontia azteca Sauss.
Prionony x atrata Lep., var. brunnipes Cr.
Ammophila gryphus Sm.

Family CEROPALIDÆ.

Priocnemis texanus Cr.
Sophropompilus relativus Fox.
Anoplius funereus Lep.

Family VESPIDÆ.

Polistes exclamans Vr.

Family EUMENIDÆ.

Zethus spinipes Say.
Odynerus (Leionotus) leionotus Vr.
Ancistrocerus capra Sauss.
catskillensis Sauss.
fulvipes Sauss.
Symmorphus walshianus Sauss.

Family BETHYLIDÆ.

Epyris armifera Say.

Family TIPHIIDÆ.

Tiphia tarda Say.

Family MUTILLIDÆ.

Sphærophthalma sparsa Fox.

Family PONERIDÆ.

Proceratium croceum Roger.

Family MYRMICIDÆ.

Cremastogaster lineolata Say.
lineolata Say, subsp. læviuscula Mayr.
Solenopsis molesta Say.
texana Emery.
Myrmecina graminicola Forster, subsp. americana Mayr.
Monomorium minutum Mayr., var. minimum Buckley.
Myrmica rubra Linne.
Stenamma tennesseense Mayr.

Family DOLICHODERIDÆ.

Iridiomyrmex analis Andre, var.

Family FORMICIDÆ.

Camponotus castaneus Latr., subsp. americanus Mayr.
marginatus Latr., var. minutus Emery.
marginatus Latr., var. nearcticus Emery.
Prenolepis imparis Say.
Lasius interjectus Mayr.
niger L., var. americanus Emery.
umbratus Nyl., var.
Formica fusca L., var. subsericea Say.
fusca L., subsp. subpolita Mayr.
schaufussi Mayr.

Family PROCTOTRYPIDÆ.

Proctotrypes belfragei Ash.
terminalis Ash.

Family BELYTIDÆ.

Zelotypa texana Ash.
Pantoclis analis Ash.

Family SCELIONIDÆ.

Prosacantha punctiventris Ash.

Family FIGITIDÆ.

Aspicera albihirta Ash.

Family CHALCIDIDÆ.

Haltichella onatas Wk.

Family EUCHARIDÆ.

Orasema coloradensis Ash.

Family ICHNEUMONIDÆ.

Cratichneumon extrematatis Cr.
Stiboscopus oryxicornis Vr.
Pezomachus alogus Vr.
Cryptus albitarsus Cr.
Harrimaniella pæneimitatrix Vr.
Ephialtes pygmæus Walsh.
Pimpla inquisitor Say.
parvialba Vr.
Glypta aprilis Vr.
Callidiotes kansensis Brues.
Sychoportus tuckeri Vr.
Ophion idoneum Vr.
Campoplex villosus Nor.
Amorphota augusta Vr.
nocturna Vr.
pænexareolata Vr.
perrivalis Vr.
Angitia autumnalis Vr.
Idechthis biconjugatus Vr.
Ischnoscopus tæniatus Vr.
Limneria lawrencei Vr.
perdistincta Vr.
virgilis Vr.
Ceratosoma fasciata Cr.
Mesochorus noctivagus Vr.
Thersilochus mimeticus Vr.
quintilis Vr.
Pristomerus appalachianus Vr., var. dorsocastaneous Vr.

Family ALYSIIDÆ.

Œnonogastra microrhopalæ Ash.
Aphæreta delosa Vr.
subtricarinata Vr.
Dinotrema signifrons Vr.
Aspilota columbiana Vr.

Family BRACONIDÆ.

Lysiphlebus succineus Vr.
Meteorus noctivagus Vr.
relativus Vr.
Macrocentrus atriceps Cr.
delicatus Cr.
Zele crassicalcaratus Vr.
Cenocœlius politifrons Vr.
Brachistes nocturnus Vr.
Calyptus (Brachistes) rotundiceps Cr.
Chelonus texanus Cr.

Agathis media Cr.
Crassomicrodus divisus Cr
Microdus castaneicinctus Vr
pimploides Vr.
wichitaensis Vr.
Apanteles congregatus Say.
congregatus Say, var.
hemileucæ Riley.
ensiger Say.
xylina Say.
Pseudapanteles bisstigmata Say.
Microgaster tuckeri Vr.
Microplitis croceipes Cr.
Biosteres indotatus Vr.
Biachasma appalachicola Vr
secunda Vr.
Opius aberrans Vr.
basiniger Vr.
luteiceps Vr.
nigrocastaneus Vr.
Iphiaulax rugator Say.
Melanobracon ulmicola Vr
Bracon kansensis Vr.
piceiceps Vr.
Rhogas melanothorax Vr.
Hedysomus wichitus Vr.
Hormiopterus claripennis Brues.
Phænodus caddous Vr.

Family SIRICIDÆ.

Paururus nigricornis Fab.

Family CEPHIDÆ.

Cephus trimaculatus Say.

Family HYLOTOMIDÆ.

Schizocera zabriskii Ash.
Hylotoma miniata Klug.

Family SELANDRIIDÆ.

Blennacampa pygmæa Say.
Endelomyia rosæ Har.

Family NEMATIDÆ.

Pteronus latus Mar.

Family TENTHREDINIDÆ.

Emphytus apertus Nor.
Tenthredo variegata Nor.

A NEW BIRD FOR THE KANSAS LIST, TAKEN AT LAWRENCE.

By L. L. DYCHE, University of Kansas, Lawrence.

AT THE twenty-first annual meeting of the Kansas Academy of Science, which was held at Leavenworth, November 1 and 2, 1888, both Col. N. S. Goss and Dr. F. H. Snow reported the surf-scoter, *Œdemia perspicillata*, as occurring in Kansas for the first time. The single specimen to which they referred was taken October 29, 1887, above the Lawrence dam, by Mr. A. L. Bennett, a student of the writer at that time.

On October 24, 1908, just twenty-one years later, another scoter was secured above the Lawrence dam, by Mr. George Weyermiller. This specimen proved to be a young female American scoter, *Œdemia americana*. Just one week later, Mr. Edward E. Brown, of the University of Kansas, shot another specimen of the same species, at Lake View, about five miles northwest of Lawrence. Each of the above specimens was alone when killed. Both birds have been mounted by Mr. Alex. Wetmore, a museum assistant of the writer, and added to the University bird collections.

The American scoter is found throughout about the same regions as the surf-scoter and the white-winged scoter. The scoters belong for the most part to the northern part of the North American continent. They especially occur in the neighborhood of Newfoundland, the Gulf of St. Lawrence and the Great Lakes. In winter these birds are common on the Atlantic coast, and individuals are said to wander as far south as Florida.

The American scoter also lives and breeds on the Behring Sea coast of Alaska and adjacent islands and territory. Stragglers have been picked up in a number of the northern and north-central states and as far south as Lawrence, Kan.

The scoters are mollusk-eating ducks and are not considered a very good table bird. The writer knows from his own dissections that they eat fish; and the meat of specimens killed in Alaska was so strongly tainted with fish that no member of my party, except the Indians, could eat it.

THE POISON-GLANDS OF A RATTLESNAKE DURING THE PERIOD OF HIBERNATION.

By L. L. DYCHE, University of Kansas, Lawrence.

IN 1905 and 1906 the writer spent about two months near Wa Keeney, Trego county, Kansas, collecting birds and mammals. He made his headquarters on Dr. A. B. Jones's ranch with Mr. Chas. Steinberger, who at that time lived on the ranch.

While riding over the high prairies about five miles south of Wa Keeney one afternoon late in October, 1906, the writer and Mr. Steinberger came upon two (presumably a pair) rattlesnakes. They were sunning themselves near the mouth of a prairie-dog hole. It was quite a surprise to see the snakes, as the weather only a few days before had been quite cold, with heavy frosts and some snow and ice. The weather, however, had moderated, and with the wind in the southwest and the sun shining it was quite warm on that particular afternoon.

I had always supposed, without thinking much about it in particular, that when snakes had once been driven to their winter quarters by cold weather they remained in their hibernating dens until the warm air of spring-time induced them to come forth. I learned, however, from ranchmen who lived in the neighborhood, that this particular species of snake, *Crotatus confluentus*, was sometimes seen basking in the sun near holes in prairie-dog towns as late as the middle of November and as early as the middle of March.

At the sight of one of the snakes, which was coiled about four feet from his den, my friend, Mr. Steinberger, grabbed a shotgun and jumped to the ground. The snake made a quick dash for its den and received a load of shot that blew it into the prairie-dog hole. This commotion disturbed the other snake that was coiled about six feet from the hole. It made a quick rush for the hole, almost crawling over Mr. Steinberger's feet. He got a quick backward movement on himself when he saw the snake at his feet, but managed, in the moment of excitement, to give the snake a load of shot, at a distance of a few feet, that blew it away from the edge of the hole.

This snake was three feet long and its body was almost severed about eight inches from its head. After looking down a hole that

seemed to have no bottom for the first snake, we placed snake No. 2 in the buggy and drove to the ranch.

Neither snake used its rattle or showed any signs of fight. Next morning, at the breakfast table, Doctor Jones and Mr. Steinberger expressed a desire to see and examine the poison-glands of the snake. After breakfast we went to the tool-house and machine-shop, where we spread the snake out on a board and began our dissections. The skin was carefully removed from the snake's head. The fangs, the muscles by which they were controlled, as well as the peculiar action and mechanism of the jaws, were examined. By removing some of the muscles the poison-glands were laid bare. Much to our surprise there was not a drop or even a trace of poison in them. They were empty and shrunken, at least as compared with the glands of other rattlesnakes which the writer has examined after the poison had been removed. The complete absence of poison in the glands naturally gave rise to some speculation and discussion. The snake, judging from the normal condition of its body organs and the amount of fat it had stored up, must have been in a healthy condition. It was killed almost instantly and had no chance to get rid of the poison by biting any object. Even though it had bitten some object, it is hardly possible that it could have ejected all the poisons from the glands.

About the only reasonable idea that suggested itself was that during the winter season, at least in cold climates, where snakes hibernate, the rattlesnake and perhaps other poisonous snakes do not have venom in the poison-glands. The idea of an organ being developed for some special use and then being dispensed with is in harmony with many things that occur in nature. I had hoped to get some live specimens of rattlesnakes and fix a place for them to go into winter quarters and at the proper time dig them up and make further investigations before presenting a paper upon this subject.

However, rattlesnakes are not very common, except perhaps in a few unfrequented localities, and persons who are willing to catch live rattlesnakes for the moderate sum of two dollars each, and keep them until a naturalist can get hold of them, are also not very common.

HABITS OF PARASITIC HYMENOPTERA, II.

By CHARLES H. WITHINGTON, University of Kansas, Lawrence.

LYSIPHLEBUS CERASAPHIS (FITCH). Plate II.

DESCRIPTION.

THIS parasite "is black with its palpi or feelers and legs pale yellowish brown; antennæ almost as long as the body, 18-jointed, the third and following joints equal, cylindric, thrice as long as broad, the last elongated ovate; abdomen elliptic, rather narrower and shorter than the thorax, scarcely pedicelled at its base, shining, tinged with brownish; wings pellucid, stigma smoky white. Length, 0.07." (Fitch's First Annual Report.)

HABITS AND LIFE-HISTORY.

Copulation occurs soon after emergence, and the method of approach and action is precisely that described in *Lysiphlebus* sp. The female seeks her prey, *Siphonophora rosæ*, and deposits her eggs in much the same manner as *Lysiphlebus* sp. (*tritici*), except that in seven instances out of ten she was seen to bring the tip of her abdomen under her body before she was within half an inch of the aphid. If for some reason the aphid becomes aware of the parasite's presence and begins to move, the parasite will stop and apparently watch the aphid, and just as soon as it becomes quiet the *Lysiphlebus* will thrust her ovipositor into the body of the aphid and then go on in search of another. In one instance a large aphid, upon being disturbed by the parasite, kept jerking her body from side to side for eleven minutes, and during all this time the parasite waited. While the parasite is watching an aphid the antennæ are not touching the leaf but pointing toward the louse and held perfectly rigid. (Plate II.)

About three days after the aphid is parasitized it stops reproducing, and if examined closely the abdomen is seen to be slightly enlarged, and in two more days a brownish object inside is perceptible. This at the end of the eighth day resembles a crescent in shape and shows very plainly through the wall of the now swollen abdomen. Soon the abdomen begins to turn brown, and two days later the louse becomes attached firmly to the leaf or stem. By this time the body of the parasitized aphid is swollen until it is almost round, light brown in color, and the skin hard and horny in appearance. In five or six days more the parasite is ready to

leave its host. It then cuts out a neat circular piece near the caudal end of the body and emerges head first.

The writer first found this parasite at Manhattan, Kan., November 17, 1907, in Mr. Moore's east greenhouse. The infestation of aphids in this house was found to range from three to four on each rose plant. In another house about 100 yards west the infestation was so great that parts of the rose plants were covered with lice. On inquiry it was found the same methods and same preparation were used for fumigating both houses. In the house without the parasite Mr. Moore found it necessary to fumigate at least once every week, while in the other he fumigated only once every month, and then more as a precaution than as a remedy. His reason for the difference in the apparent killing power of the smoke in the two houses was that the west house, being more open, did not retain the smoke long enough to kill the aphids; the other, being less open, retained the smoke much longer. Careful examination of the west honse revealed no signs of the parasite.

On December 2 five females and two males of *Lysiphlebus cerasaphis* which had not been seen in copulation were introduced. The females began at once to sting the aphids, but no signs of parasitism appeared until January 6, 1908. From this time on the parasite increased in numbers very rapidly, so that by April 1 the percentage of unparasitized aphids was exceedingly small. The number of both parasitized and unparasitized aphids on ten leaflets were counted with the following result:

Number of leaflet	1	2	3	4	5	6	7	8	9	10	Totals.
Number of parasitized aphids	17	6	9	1	6	13	8	5	14	6	84
Number of unparasitized aphids	3	1	0	2	3	0	0	1	2	0	12

Percentage of aphids parasitized, 87.3.

By May 25 it was almost impossible to find any unparasitized aphids in this house, and Mr. Moore said he had not "smoked" since the middle of March. In these observations neither temperature nor moisture records were kept.

On April 12 the *Lysiphlebus cerasaphis* was found in two greenhouses in Topeka, Kan. In these it was almost impossible to find any unparasitized aphids, while in another greenhouse in Topeka, where no signs of parasitism were found, the rose plants were very badly infested with lice. On inquiry it was found that the owners of all three houses used the same material for fumigating; but while apparently so effective in the two where the parasites were found that fumigation was unnecessary oftener than once in three

weeks, in the one where the parasites were not found it was necessary to fumigate every week, and sometimes two evenings in succession. Even this was not sufficient to keep them under complete control.

To determine what hosts *Lysiphlebus cerasaphis* can use, fertilized females were tried on *Siphonophora rosæ* (Reaumur), the daisy aphid, *Toxoptera graminum* (Rodani), *Macrosiphum* sp., *Rhopalosiphum dianthi* (Shrank), and *Myzus persicæ* (Sulzer), but it was found that they worked only on *Siphonophora rosæ.*

EFFICIENCY.

To determine how many aphids one parasite could kill, cages were prepared. as follows: A small rose plant was set in each of five nine-inch flower pots; on each plant were placed 200 lice; the plant was then, covered by a cloth-capped lantern globe, and one pair of newly emerged parasites introduced. During the entire experiment careful moisture and maximum and minimum thermometer records were kept.

Number of cage.....	Number of lice introduced.....	Date of lice introduction.....	Date of parasite introduction.....	Number and sex of parasites....		Date of first fixation.....	Date of first parasite emergence.....	Date of maximum emergence.....	Number of parasites emerged.....	Number of males.....	Number of females..	Length of time from egg to adult, days..	Average daily mean temperature.....	Average daily moisture.....
				♂	♀									
1.....	200	5—9	5—9	1	1	5—19	5—24	5—26	52	14	38	15	75.4	72.4
2.....	200	5—9	5—9	1	1	5—20	5—25	5—26	97	32	7	16	75.3	72.4
3.....	200	5—9	5—9	1	1	5—20	5—26	5—27	61	14	47	17	73.8	73.1
4.....	200	5—9	5—9	1	1	5—20	5—25	5—26	39	36	61	16	75.3	72.4
5.....	200	5—9	5—9	1	1	5—19	5—25	5—26	105	10	95	16	75.3	72.4
Average.....									70.8	21.2	49.6	16	75.4	72.5

It was found that one fertilized female of *Lysiphlebus cerasaphis* at a mean daily temperature of 75.4 degrees F. and under a mean daily moisture of 72.5, successfully parasitized from 39 to 105 *Siphonophora rosæ*, with an average of 70.8. The length of time required for the parasite to pass from egg to adult was 16 days, with 15 to 17 days as extremes. It was also found that of the 354 parasites which emerged from this experiment, 70 per cent, or 248, were females.

To determine the rate per day of reproduction, the number produced and the length of life of *Siphonophora rosæ*, four cages were prepared, and handled as follows: In each of four six-inch flower-pots, small rose cuttings were planted, and on each was placed a young aphid born February 4, 1908; each plant was then covered by a cloth-capped lantern-globe. When the aphids began

to reproduce the young were removed every day at noon. Careful maximum and minimum thermometer records as well as moisture records were kept during the entire experiment.

Date of lice introduction.	Date when breeding began.....	Number of days from birth to maturity...	Number of young.....	Length of breeding period, days.....	Date of death.....	Length of life, days...	Mean daily temperature.....	Mean daily moisture..
2—4.....	2—17	14	26	27	3—15	41	62.7	80.8
2—4.....	2—16	13	82	48	4— 4	61	63.4	73.3
2—4.....	2—15	11	88	42	3—27	53	63.8	77.9
2—4.....	3— 3	28	108	58	4— 2	86	63.6	78.8
Average.....	.....	19	76	43.9	.....	60.2	63.4	79.1

It was found that one aphid at a mean daily temperature of 63.4 degrees F. and in a mean daily moisture of 79.1, reached maturity in 16 days, with 14 and 28 days as extremes. Average number of young per day, 1.7, with an average of 76 during the reproduction period, with 26 and 108 as extremes. Average length of life, 60 days, with 41 and 86 as extremes.

RELATIVE RATE OF INCREASE.

The preceding data show the average period of reproduction of *Siphonophora rosæ* to be 43 days, with an average daily reproduction of 1.7. The young at the end of 16 days also begin to reproduce. It is now readily found that the progeny of a single aphid at the end of 48 days will be 1201 agamic females.

The average length of time for the parasite to pass from egg to adult has been found to be 16 days, and one fertilized female of *Lysiphlebus cerasaphis* successfully parasitized an average of 70.8 lice, 70 per cent. of which were females. From this it can be readily calculated that the total progeny at the end of 48 days or third generation would be 177,261 individuals. Theoretically the progeny of one parasite at the end of 48 days would be able to kill the progeny of 140 lice living under the same conditions.

The fact that this parasite seems unable to utilize other lice as hosts will not operate seriously against its usefulness as an enemy to the "green fly," for the reason that the green fly passes the whole year on rose plants and is a host always available.

It seems altogether probable that in this parasite we have an efficient enemy of the green fly, and possibly a method of controlling this one of the most serious insect enemies of the rose grower.

EPHEDRUS ROSÆ N. SP. Plate I.

DESCRIPTION.

Male and Female.—Length, ♂ 1.3 to 1.5 mm., ♀ 2.2 to 2 5 mm. Polished black; mandibles testaceous; palpi dark honey-yellow; legs honey-yellow; abdomen black; petiole dark honey-yellow; ovipositor brownish black. Antennæ 11-jointed;* first joint and proximal half of second black, distal half of second testaceous to honey-yellow; pedicel (one-third as long as second joint) honey-yellow, proximal half of third joint honey-yellow to testaceous, distal half of third joint and remainder of antennæ concolorous black. Wings hyaline; venation brownish; the recurrent nervure and first transverse cubitus joining in front of the second cubital cell.

HABITS AND LIFE-HISTORY.

Soon after emerging the parasites copulate and the female begins running nervously up and down the leaves and stems until she finds an aphid not parasitized. Then she throws the tip of her abdomen under her body between her legs, and with a quick forward, upward and downward thrust pushes her ovipositor through the dorsal wall into the body of the aphid, at the same time bringing her wings up as if ready to fly. It takes this parasite from fifteen to forty-five seconds to oviposit, and if the aphid begins to move during the process of oviposition, the parasite follows, keeping her ovipositor in the aphid's body until she has laid an egg. After parasitizing one aphid the parasite stops, apparently to rest, and rubs the tip of her abdomen vigorously with her hind tarsi. She then goes on in search of another victim. In no instance has the writer seen this parasite parasitize two aphids in succession without stopping and rubbing the tip of the abdomen with hind tarsi.

About three days after the aphid is parasitized it stops reproducing, and in one or two days the abdomen, if closely examined, is seen to be slightly enlarged. In another day a dark object is visible in the abdomen. This, at the end of the ninth day after the egg has been laid, resembles a crescent in shape, and shows very plainly through the wall of the swollen abdomen, which has now begun to turn black. In two more days the aphid has become attached very firmly to a leaf or some other object. By this time the body of the parasitized aphid is swollen until it is almost round; is dull black in color and the skin has a horny appearance. In eight days more the parasite is ready to leave its host. To accomplish

* The pedicel in description is not counted as a regular joint.

this it cuts a neat circular opening at the caudal end of the body, through which it promptly emerges.

DISTRIBUTION.

The writer first found these parasites at Manhattan, Kan., in Mr. Moore's greenhouse, November 11, 1907; later in two greenhouses in Topeka, Kan., April 12, 1908; and one in Lawrence, Kan., April 13, 1908. In Mr. Moore's and the two greenhouses in Topeka the *Lysiphlebus cerasaphis* was also present, while in the one at Lawrence there were no signs of *Lysiphlebus cerasaphis*, but a number of the *Ephedrus*. The lice in this house were two to every plant.

EFFICIENCY.

To find the number of aphids a single *Ephedrus* could parasitize, cages were prepared, as follows: A small rose plant was set in each of four nine-inch flower-pots; on each plant about 200 lice were placed; the plant was then covered by a cloth-capped lantern-globe and one pair of newly emerged *Ephedrus* introduced. During the entire experiment careful moisture and maximum and minimum thermometer records were kept.

Number of cage	Number of lice introduced	Date of lice introduction	Date of parasite introduction	Number and sex of parasites		Date of first fixation	Date of first parasite emergence	Date of maximum emergence	Number of parasites emerged	Number of males	Number of females	Length of time from egg to adult, days	Average daily mean temperature	Average daily mean moisture
				♂	♀									
1	200	5—9	5—9	1	1	5—21	5—29	5—30	19	7	12	20	75.9	73 3
2	200	5—9	5—9	1	1	5—22	5—31	6— 1	76	44	32	22	80.0	73.6
3	200	5—9	5—9	1	1	5—22	5—30	5—30	31	17	14	21	75.9	73.3
4	200	5—9	5—9	1	1	5—20	5—29	5—30	83	28	55	20	75.9	73.3
5	200	5—9	5—9	1	1	5—22	5—31	6— 2	57	31	26	22	81.1	73.3
Average									53.2	23.4	22.9	21	77.7	73.3

It was found that one fertilized female of *Ephedrus rosæ* successfully parasitized under a mean daily temperature of 77.7 degrees F., and a mean daily moisture of 73.3, from 19 to 38 *Siphonophora rosæ*, with 53.2 as an average. The length of time required for the parasite to pass from egg to adult was 21 days, with 20 to 22 days as extremes. Of the 266 parasites which emerged, 52.2 per cent., or 139, were females.

To determine what other aphids the *Ephedrus* could use for a host, fertilized females were tried on *Siphonophora rosæ* (Reaumur), the daisy aphid, *Toxoptera graminum* (Rodani), *Macrosiphum* sp., *Rhopalosiphum dianthi* (Shrank), and *Myzus persicæ* (Sulzer), but it was found they used *Siphonophora rosæ* only for a host.

RELATIVE RATE OF INCREASE.

From the preceding data on *Siphonophora rosæ* it is readily calculated that the progeny of a single louse at the end of 42 days will be 929 agamic females.

The average length of time for the *Ephedrus* to pass from egg to adult has been found to be 21 days. One fertilized female successfully parasitized an average of 53.2 lice, 50.2 per cent. of which were females. From this it is readily calculated that the total progeny at the end of 42 days would be 1529 individuals. Theoretically, the progeny of one *Ephedrus* shows an increase of 597 above the progeny of one *Siphonophora rosæ* at the end of 42 days.

Thus the parasites would be able to control the ravages of the rose "green fly." This shows to a certain extent the economic value of these parasites to the florist, for he could avoid the extra expense and labor of fumigating by introducing the *Lysiphlebus cerasaphis* and *Ephedrus* sp., which have been proven beyond a doubt to be an efficient natural check to the rose aphid under good greenhouse conditions.

In conclusion, my thanks are especially due to Dr. T. J. Headlee, under whose directions these experiments were performed and this paper written. I wish also to express my obligations to Miss H. E. Branch for the drawings, and Mr. Charles T. Brues, of Milwaukee Museum, for determining the *Lysiphlebus cerasaphis* (Fitch).

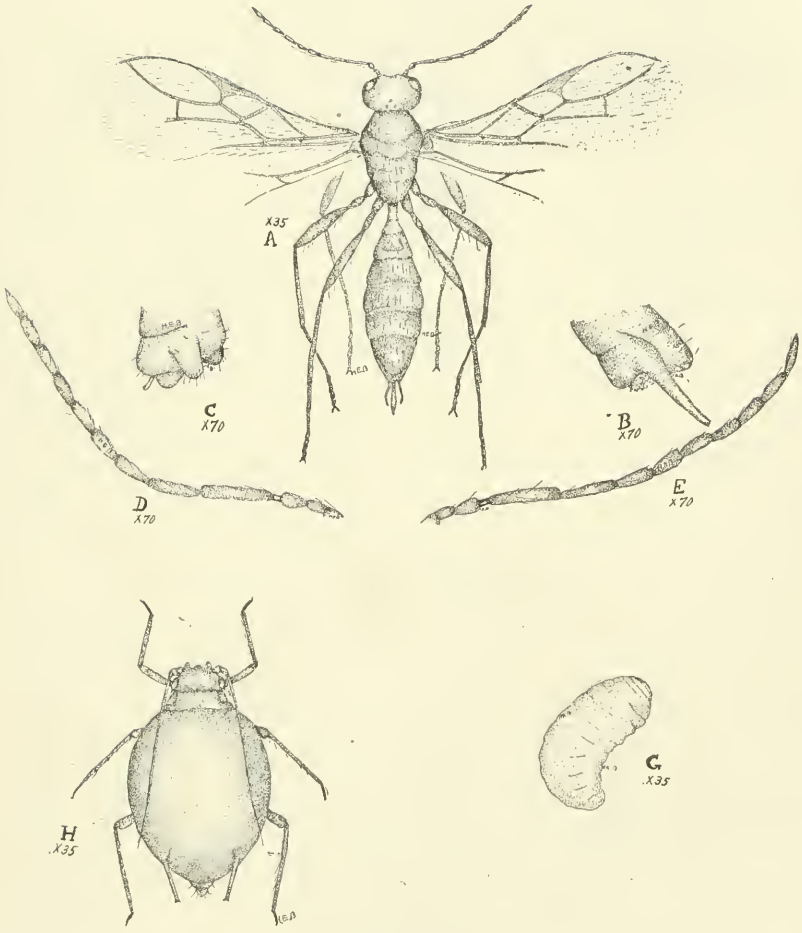


PLATE I.

Ephedrus rosæ n. sp.

FIG. A. Dorsal view of adult female.
" B. Tip of abdomen of female.
" C. Tip of abdomen of male.
" D. Antennæ of male.
" E. Antennæ of female.
" G. Full grown larvæ.
" H. Aphid with parasite in pupæ state.

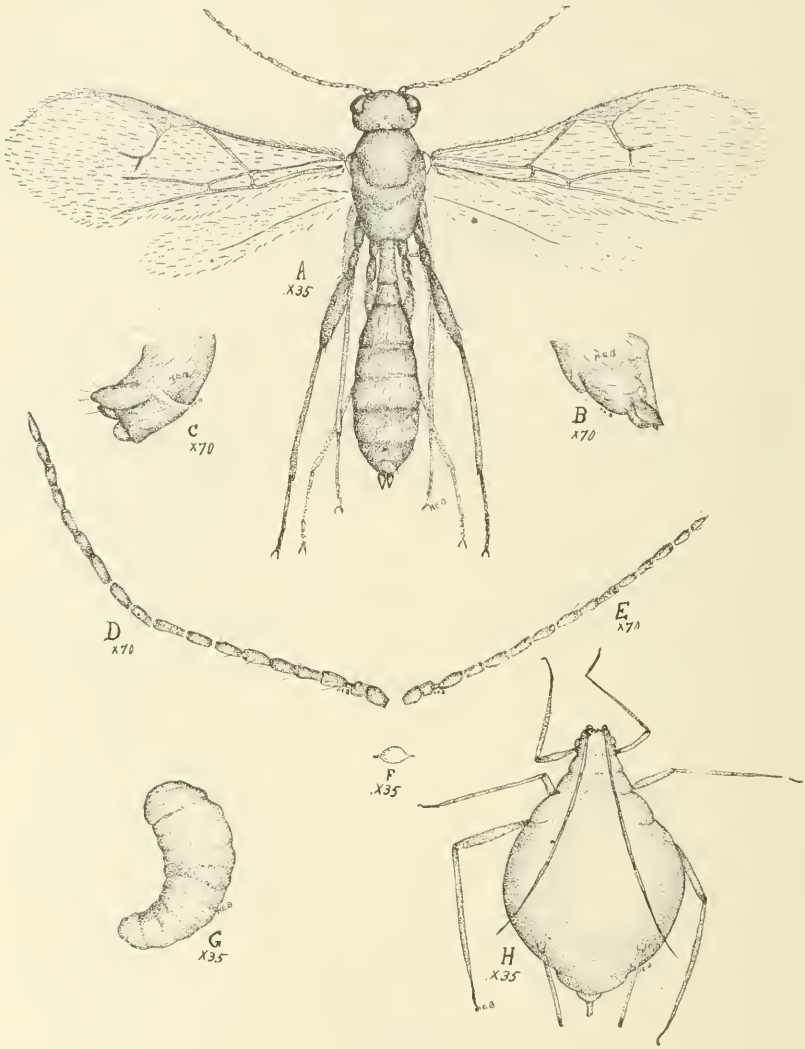


PLATE II.

Lysiphlebus cerasaphis (Fitch).

FIG. A. Dorsal view of adult female.
" B. Tip of abdomen of female.
" C. Tip of abdomen of male.
" D. Antennæ of male.
" E. Antennæ of female.
" F. Egg of parasite.
" G. Full grown larvæ.
" H. Aphid with parasite in pupæ state.

WINTER CONDITION OF LENTICELS.

By Leslie A. Kenoyer, Independence.

ON THE twigs and younger branches of most woody dicotyls there are scattered over the smooth epidermis rough, corky places known as lenticels. A microscopic examination reveals the fact that the tissue just beneath the surface of the lenticel is of a porous nature, the cells being loosely fitted together and separated by large intercellular spaces. Lenticels are developed from stomata, the openings for interchange of gases which occur not only on leaves, but also on young, tender stems. The porous tissue filling the lenticel is produced by the multiplication of cells in either the phellogen or the ground tissue just beneath the stoma.

The origin and structure of lenticels lead to the belief that they are intended as passages for the circulation of gases. And since they are commonly on parts no longer green, it is generally agreed that their main function is in respiration. The large intercellular spaces found between the corky cells of the lenticel, and often between the cells in the portion of the collenchyma or parenchyma which is just beneath them, admit air to the inner tissues of the plant; and since there are smaller spaces in nearly all the tissues, the cells of the plant individually have access to atmospheric oxygen.

In Gregory's Elements of Plant Anatomy is found the following statement: "At the close of summer, when the time for winter rest draws near, the lenticel is usually closed by the last layers of the phellogen growth; that is, these layers remain a continuous collection of cells and their walls become suberized. In the spring-time the phellogen renews its activity, and the new cells, pushing up as before, break these layers apart and the opening is established anew."

To ascertain the extent to which lenticels are closed I conducted a series of experiments at the University of Kansas in the fall and winter of 1907–'08. My apparatus consisted of a J-shaped glass tube with the tip of the short arm bent outward from the long arm. The out end of the twig experimented upon was attached to the short arm by means of a short rubber connection, which was wrapped with wire around both the glass tube and the twig to make it air-tight. The short arm and twig were immersed in a vessel of water and mercury was poured into the long arm through

a funnel at its upper end. The pressure of the mercury compresses the air in the short arm, forcing it through the twig and causing it to appear as bubbles wherever there are openings in the twig. The more minute the openings the greater the pressure required to produce bubbles at a visible rate. It is indeed true that when bubbles are obtained at a greater pressure they can also be obtained, more slowly, however, at lesser ones. So it is an exceedingly difficult matter to obtain an accurate comparison between different subjects, but my data enabled me to group them roughly into four classes. Class A consists of those in which the passage of air is least obstructed, so that bubbles were readily obtained with a pressure of 10 cm. or less of mercury. Class B comprises those in which 10 to 50 cm. was used to form the bubbles; class C those in which they were noticed at higher pressures (50 to 140 cm.), and class D those in which none were obtained by the highest pressures applied, which varied in different cases from 90 to 140 cm. and was generally maintained for a considerable length of time.

One hundred twigs belonging to thirty-five different species were tested between October and January, after the season's growth had ended and mostly after the leaves had fallen. The results were as follows, a number in parentheses following each species in which the same result was obtained from more than one twig.

Class A.—Salix alba, Hicoria ovata, Gymnocladus canadensis, Rhus copallina (2), Æsculus arguta, Acer saccharinum, Acer saccharum (2), Asimina triloba (2). Eleven twigs of eight species.

Class B.—Salix alba, Populus deltoides, Quercus acuminata, Corylus americana, Tuglans nigra, Hicoria ovata, Ulmus fulva (2), Ulmus americana, Celtis occidentalis (3), Plantanus occidentalis, Fraxinus lanceolata, Sambucus canadensis (2), Prunus americana (3), Gleditsia triacanthos, Gymnocladus canadensis, Amorpha fruticosa, Rhus aromatica, Ailanthus glandulosus, Acer negundo. Twenty-six twigs of nineteen species.

Class C.—Juniperus virginiana, Populus deltoides, Juglans nigra, Ulmus americana, Celtis occidentalis (2), Toxylon pomiferum (2), Plantanus occidentalis, Catalpa speciosa, sanbucus canadensis, Prunus cerevisieæ, Gleditsia triacanthos, Gymnocladus canadensis (3), Cercis canadensis, Rhus glabra (3), Xanthoxylum americanum (3), Acer saccharinum (2), Acer negundo (3). Twenty-eight twigs and seventeen species.

Class D.—Juglans nigra, Ulmus americana, Catalpa speciosa, Cornus asperifolia, Prunus americana, Prunus persica, Pyrus coronaria, Gleditsia triacanthos (3), Cercis canadensis (2), Rhus copal-

lina, Ailanthus glandulosus, Acer saccharinum (8), Acer negundo (11), Tilia americana, Asimina triloba. Thirty-five twigs and fifteen species.

Sixty-five of the twigs tested seemed to have some or all of their lenticels open for respiration during the winter months, while the other thirty-five did not have such provision. In about half of the former cases, however, bubbles were seen from one-half or fewer of the lenticels immersed, in some instances from but a small percentage of them.

It was noticed that the two-year-old growth has generally more open lenticels than the growth of the season, and that the three-year-old growth has more than the two-year. Likewise, the older lenticels appeared to have the freest passage for air.

It was also rather remarkable that in the case of some species tested, notably the papaw, some twigs gave decidedly positive and others as decidedly negative tests. In several cases open and closed lenticels of a species were marked, imbedded in paraffin, and sectioned. No difference could be detected with the microscope. In no case could an open intercellular passage be traced to the interior of the stem, there seemingly being just beneath the filling tissue a layer of cork without spaces such as histologists describe.

It appeared that generally the rank-growing shoots, such as the water-sprouts from the base of the tree, had the lenticels more generally closed than did the smaller or more stunted shoots.

In class D are only four species which were not placed also in one of the other classes on account of their lenticels having been in some instances found open; and of each of these four species only one twig was tested.

Lenticels were looked for on the roots of several species and were found well developed on many but not all of them. Their structure is quite similar to that of stem lenticels. I tested a few with the pressure apparatus, with the following results:

Class B.—Juglans nigra, Rhus glabra (2).

Class C.—Rhus glabra (2).

Class D.—Rhus glabra (2), Ailanthus glandulosus (2), Xanthoxylum americanum (2), Rosa sp., Sambucus canadensis.

Summary.—Four with open lenticels, eight without. In several instances root-lenticels were closed while the lenticels on the stems of the same plant were open.

Late in May and early in June, 1908, I tested the following twigs, all of which had made considerable growth:

Class A.—Ulmus americana (2).

Class B.—Populus deltoides (2), Ulmus americana, Gleditsia triacanthos (2), Ailanthus glandulosus, Acer saccharinum, Acer negundo, Asimina triloba (2). Ten twigs of seven species.

Class C.—Juglans nigra (2), Toxylon pomiferum, Gleditsia triacanthos, Cercis canadensis (2), Acer saccharinum. Seven twigs of five species.

None of the nineteen twigs examined gave entirely negative results, although in several cases bubbles were formed slowly and from only a comparatively small proportion of the lenticels. On the whole, however, lenticels seem to be open in greater numbers in the spring than in the fall. But the fact that so many of them are open in the fall and winter seems to be a point worthy of further investigation.

INSECT TYPES AND COTYPES.

A PRELIMINARY LIST OF THOSE IN THE FRANCIS HUNTINGTON SNOW ENTOMOLOGICAL COLLECTIONS.

By CHAS. H. WITHINGTON, Museum Assistant in Systematic Entomology, University of Kansas, Lawrence.

THE following is a list of the types and cotypes in the Francis Huntington Snow entomological collections, University of Kansas, Lawrence:

ORDER NEUROPTERA.

HEMEROBIDÆ.

Glenuyus snowii Banks.

ORDER ORTHOPTERA.

MANTIDÆ.

Stagomantis gracilipes Rehn.

TRYXALINÆ.

Cordillacris pima Rehn.

ŒDIPODINÆ.

Lactista arphoides Rehn.
Trimerotropis snowi Rehn.

ACRIDIINÆ.

Melanoplus blatchleyi Scudd.
bruneri Scudd.
gladstoni Brunn.
intermedius Brunn.
snowi Scudd.

LOCUSTIDÆ.

Ceuthophilus tuckeri Rehn.
Udeopsylla serrata Rehn.

ORDER HEMIPTERA-HETEROPTERA.

COREINA.

Alydus setosus V. D.

BERYTIDÆ.

Jalysus wickhami V. D.

CAPSIDÆ.

Xestœorus nitens Reut.
Diaphnidia debilis Uhl.
Orthoptylus translucens Tucker.
Oncotylus sericatus Uhl.

TINGITIDÆ.

Corythuca pergandei Heid.

ORDER HEMIPTERA-HOMOPTERA.

FULGORIDÆ.

Scolopsella reticulata Ball.
Oecleus snowii Ball.

BYTHOSCOPIDÆ.

Pediopsis erythrocephalus G. & B.
Idiocerus snowii G. & Pr.
perplexus G. & B.
rufus G. & B.
Agallia gilletei O. & B.

JASSIDÆ.

Memnoinia consobrina Ball.
fraterna Ball.
Parabolocratus brunneus Ball.
Deltocephalus flexuosus Ball.
Athysanus alpinus Ball.
Eutettix scitula Ball.
insana Ball.
striata Ball.
texana Ball.
snowi Ball.
osborni Ball.
Phlepsius graphicus Ball.
cumulatus Ball.
denudatus Ball.
turpiculus Ball.
Scaphoideus blandus Ball.
Lonatura noctuaga Ball.
salsura Ball.
Thamnotettix cockerelli Ball.
osborni Ball.
Empoasca atrolabes Gill.
unicolor Gill.
alboneura Gill.
nigroscuta G. & B.

ORDER LEPIDOPTERA.

HESPERIDÆ.

Pyrgus nessus Edw. (Cotype.)
polingii Barnes.
occidentalis Skinner.
Heteropia melon, var. arizonensis Skinner.
Erycides batabano Luc.

SATURNIIDÆ.

Hyperchiria zephyria Grt.

SYNTOMIDÆ.

Cosmosoma rubrogutta Skinner.
Syntomeida befana Skinner.
Scepsis packardii, var. cocklei Dyar.

LITHOSIIDÆ.

Ruscino arida Skin.

ARCTIIDÆ.

Alexicles aspersa Grt.
Pygoctenucha funerea Grt.
Hemihyalea labecula Grt.
Bertholdia trigona Grt.

NOCTUIDÆ.

Cyathissa quadrata Sm. (Cotype.)
Perigea morsa Smith. (Cotype.)
Hadena burgessi Morr.
Oncocnemis major Grt.
Acopa perpallida Grt.
Aleptina flavomedia Sm. (Cotype.)
Rhynchagrotis minimalis Grt.
bimarginalis Grt.
mirabilis Grt.
Peridroma grandipennis Grt.
Noctua conchis Grt.
beata Grt.
Chorizagrotis terrealis Grt.
Feltia circumdata Grt.
Porosagrotis catenula Grt.
Euoxa olivalis Grt.
ura Sm. (Cotype.)
flavidens Sm.
cænis Grt.
munis Grt.
infausta Wlk., var. rufula Sm.
verticalis Grt.
basalis Grt.
anacosta Sm. (Cotype.)
Richia parentalis Grt.
distichoides Grt.
Mamestra prodeniformis Sm.
artesta Sm. (Cotype.)
arida Sm. (Cotype.)
æsculi Sm. (Cotype.)
Barathra occidenta Grt.
Trichorthosia parallella Grt.
Anarta mimula Grt.
Hydroecia juvenalis Grt.
Pyrrhia stilla Grt.
Heliothis suavis Hy. Edw.
Rhodosea julia Grt.
Grotella dis Grt.
Bessula luxa Grt.
Autographa snowi Hy. Edw.
Marasmalus inficita Wlk. var. histrio Grt.
Eucalyptra umbonalis Sm.
Escaria clauda Grt.
Metoponia nanata Neum.
Minufolia instans Sm.
Homopyralis miserulata Grt.
cinctus Sm.
Euclidia intercalaris Grt.
Calipters bucetum Grt.
Renia rigida Sm.
Hypenula cominalis Sm. (Cotype.)
Pathis albisinulatus Sm. (Cotype.)
Rhescipha snowi Skinner.

LASIOCAMPIDÆ.

Gloveria diasoma Grt.

GEOMETRIDÆ.

Cœnocalpe fervifactaria Grt.
formosata Strck.
Emplocia inconstans Geyer.
Fernaldella stalachtaria Strck., var. alternaria Grt.
Deilinia elimaria Hulst.
perpallidaria Grt.
Sciagraphia continuata Wlk., var. curvata Grt.
Caripeta æquaharia Grt.
Glaucina puellaria Dyar. (Cotype.)
Phæoura mexicanaria Grt.
Eucaterva variaria Grt.
sabesaria Grt.
Lychnosea helveolaria Hulst.
Therina vitraria Grt.
Hyperitis indiscretata Hy. Edw.
Metanema excelsa Strck., var. simplliciaria Grt.
Sabulodes sulphurata imitata Hy. Edw.
catenulata Grt.

SESIIDÆ.

Melittia snowii Hy. Edw.

PYRALIDÆ.

Symphysa simplicialis Kearf.
Evergestis obliquilis Grt.
Elophila avernalis Grt.
Crambus dimidiatellus Grt.
Dioryctria aurantiacella Grt.

TORTRICIDÆ.

Proteoteras arizonæ Kearf.
Epinotia snowiana Kearf.

YPONOMEUTIDÆ.

Plutella yumaella Kearf.

BLASTOBASIDÆ.

Holocera arizoniella Kearf.

TINEIDÆ.

Trichophaga crescentella Kearf.

ORDER HYMENOPTERA.

TENTHREDINIDÆ.

Hylotoma conspiculata MacG.

EVANIIDÆ.

Hyptia texana Brad.

ICHNEUMONIDÆ.

Ichneumon arizonensis Vier.
egregiafascialis Vier.
citrifacialis Vier.
flavicornis Cress.
varriola Cress.

Ichneumon nigrosignatus Vier.
hemimelanorus Vier.
humphreyi Vier.
flavifascialis Vier.
maurus Cress. (Homotype.)
Amorpha pericalis Vier.
pænaxareilata Vier.
confluens Vier.
confluens Vier., mutation *a*.
confluens Vier., mutation *b*.
confluens Vier., mutation *c*.
augusta Vier.
galvestonensis Vier.
noctura Vier.
relativo Vier.
ferruginosa Vier.
Platylabus omniferrugmeus Vier.
Phygadeuon oryxicornis Vier.
spinicoxus Vier.
Cryptus citrinimaculatus Vier.
consobrinus Vier.
politicalypteras Vier.
Nematopodius exclamans Vier.
Mesostenus discoidaloides Vier.
Hemiteles manitonensis Vier.
lathroscopoides Vier.
Pezomachus homalommoide Vier.
testaceicoxus Vier.
alogus Vier.
Ophion idoneum Vier.
Eremotylus felti Vier.
Thyreodon morio Fabr., var. trancitionalis, Vier.
snowi Vier.
Nototrachys reticulatus Cress. (Homotype.)
Anomalon fulvescens, var. hemimelas Vier.
pæneferragineum Vier.
Atrometus angitioides Vier.
Campoplex photomorphus Vier.
wyomingensis Vier.
Limneria lawrencei Vier.
vigile Vier.
perdistinctum Vier.
Ischnoscopus tæniatus Vier.
Angitia autumnalis Vier.
Mesochorus noctivagus Vier.
Olesicampa melanerythrogastra Vier.
Thersilochus hamiltonensis Vier.
snowi Vier.
egregiacolor Vier.
memeticus Vier.
quintilis Vier.
Metopius grandior Vier.
Bœthus ænigmaticus Vier.
Synchnoporthus tuckeri Vier.
Agathobancus bradleyi Vier.
Pimpla parviabala Vier.
landerensis Vier.
Glypta aprilis Vier.
brunneisigna Vier.
egregiafovea Vier.
succineipennis Vier.
Arenethra leucotænis Vier.
Harrimaniella pæneimitatrix Vier.
Lampronota occidentalis Cress.

STEPHANIDÆ.

Stephanus tridens Vier.

BRACHONIDÆ.

Bracon kansensis Vier,
piceipes Vier.
Lysiphlebus succineus Vier.
Melanobracon ulmicola Vier.
Vipio erythis Vier.
picipectus Vier.
Rhogas fuscicaudus Vier.
melanothorax Vier.
Chelonus altitudinis Vier.
egregiacolor Vier.
exogyrus Vier.
nucleolus Vier.
texanoides Vier.
Microgaster tuckeri Vier.
Diochasma appalachicola Vier.
secunda Vier.
Boisteres indotatus Vier.
Ischneutidea preteroptoides Vier.
Cardiocheiles nigroclypeus Vier.
Ascogaster mimeticus Vier.
Agathis wyomingensis Vier.
Microdus agathoides Vier.
nigrotrochanter Vier.
pimploides Vier.
castaneicincta Vier.
wichitaneicincto Vier.
nigricaudus Vier.
Lytopilus azygos Vier.
Meteorus campestris Veir.
relativus Vier.
noctivagus Vier.
Dinotrema signifrons Vier.
Brachistes nocturnus Vier.
Zele crassicalcara Vier.
Cœnocelius politifrons Vier.
Iphianlax perepicus Vier.
propinquus Vier.
militaris Vier.
melanogaster Vier.
cinnabarinus Vier.
Opius aberrans Vier.
basinigrus Vier.
luticeps Vier.
nigrocastaneus Vier.
Aphereta delosa Vier.
subtricarinata Vier.
Aspilota columbia Vier.
Challidoites kansensis Brues.
Scopiarus monticola Brues.
Hormiopterus claripennis Brues.

CHALCIDIDÆ.

Leucopsis bicincta Vier.

PROCTOTRUPIDÆ.

Scelio monticola Brues.
striaticollis Brues.
venata Brues.

CHRYSIDIDÆ.

Notozus connexus Vier.
Chrysis equidens Vier.
kahli Vier.
kansensis Vier.
petronella Vier.
snowi Vier.

MUTILLIDÆ.

Mutilla crepuscula Vier.
nigricauda Vier.
prognoides.
montivagoides Vier.
quintilis Vier.
imperialiformis Vier.
strictinotus Vier.

SCOLIIDÆ.

Elis pollenifera Vier.
pollenifera Vier, var. A. Vier.

POMPILLIDÆ.

Anoplius snowi Vier.
Cryptochelius pæneparecus Vier.
Aporus ferrugineipes Vier.
Pepsis angustimarginata Vier.

SPHECIDÆ.

Sphex ashmeadi Fernald. (Cotype.)
Parasphex ferrugineus Fox. (Cotype.)

LARRIDÆ.

Ancistronoma pænerugosa Vier.
tachysphegoides Vier.
regetoides Vier.
gerbeii Vier.
Tachysphex clarkonius Vier.
crassiformis Vier.
intermedius Vier.
Nitiliopsis foxii Vier.

NYSSONIDÆ.

Gorytes guliemi Vier.
papagorus Vier.
Nysson clarcornis Vier.
intermedius Vier.

PHILANTHIDÆ.

Philanthus crassicornis Vier.
clarkonis Vier.
magdalenæ Vier.

PEMPHREDONIDÆ.

Passalœcus æqualis Vier.
Diodontus brunneicornis Vier.

CRABRONIDÆ.

Trypoxylon quintilis Vier.
negularis Vier.
Crabro canonicola Vier.
cinctibellus Vier.
clarkonis Vier.
Notoglossa calligaster Vier.
pæneomarginatus Vier.
tænigaster Vier.
Crabro papagorum Vier.
Oxybelus exclamans Vier.

EUMENIDÆ.

Odynerus amphichrous Vier,
anormiformis Vier.
cochisensis Vier.
congressus Vier.
delodontus Vier.
egregius Vier.
excentralis Vier.
guliehmi Vier.
leionolus Vier.
pimorum Vier.
microstictus Vier.
maricoporum Vier.
papagorum Vier.
pænevagus Vier.
ampanulatus Vier.
rectangulis Vier.
sulfuritimetus Vier.
pulverulanta Vier.
spectabiliformis Vier.
hidalgiformis Vier.

VESPIDÆ.

Polistes exclamans Vier.
Andrena alaskensis Vier.
delosa Vier.

APIDÆ.

Perdita klagesi Vier.
Melissodes duplocincta Ckll.
galvestonensis Ckll.
herrickii Ckll.
hexacantha Ckll.
nigrosigmata Ckll.
pallidisignata Ckll.
prælanta Ckll.
portivagans Ckll.
semitristis Ckll.
tennitarsis Ckll.
Xenoglossa pruinosa, var. limitavis Ckll.
strenua, var. Kan. Ckll.
Synhalonia gillettii, sub. sp. snowii Ckll.
fustincta Ckll.
lippias, var. sublippiæ Ckll.
Diadasia afflicta penafflicta Ckll.
Exomalopsis snowii Ckll.

ORDER DIPTERA.

TIPULIDÆ.

Eriocera eriophora Will.
obscura Will.
Rhaphidolabis debilis Will.
Tipula acuta Doane.
dorsimacula Walker.
dorsilineata Doane.

CHIRONOMIDÆ.

Tersesthes torrens Towns.
Ceratopogon dimidiatus Adams.
flavus Will. (Cotype.)

Chironomus anonumus Will. (Cotype.)
flaviventris Johan.
longimanus Will. (Cotype.)
lucifer Johan.
microcerus Will. (Cotype.)

CULICIDÆ.

Culex affinis Adams.
apicalis Adams.
particeps Adams.

MYCETOPHILIDÆ.

Ceroplatus apicalis Adams.
Platyura gracilis Will.
notabilis Will.
pulchra Will.
Sciophila angulate Adams.
nigricauda Adams.
Syntemna mutor Adams.
Neoglaphyroptera cuneola Adams.
lineola Adams.
striata Will.
Macrocera diluta Adams.
Eunoriste occidentalis Coq.

CECIDOMYIDÆ.

Asphondylia atriplicis Towns.
Cecidomyia raditæ Snow.

SIMULIIDÆ.

Simulium argus Will.
notatum Adams.
venustum Say.

STRATIOMYDÆ.

Scoliopelta lutipes Will.
Hermetia comstocki Will.
eiseni Towns.
Ptecticus sackeni Will.
Chrysochroma albipes Towns.
Macrosargus clavis Will.
Odontomyia americana Day.
flava Day.
pilosa Day.
pubescens Day.
Euparyphus albipilus Adams.
limboventris Will.
mutabilis Adams.
ornatus Will.
septemmaculatus Adams.
Clitellaria argentata Will.
Nemotelus abdominalis Adams.
bruesii Mel.
kansensis Adams.
trinotatus Mel.

TABANIDÆ.

Pangonis dives Will.
fera Will.
Silvius pollinosus Will.
Chrysops bistellatus Daeck. (Cotype).
discalis Will.
frazari Will.
pachyceras Will.
Chrysops pertinax Will.
sequax Will.
Tabanus baal Towns.
fenestra Will.
fratellus Will.
fur Will.
guttatus Towns.
hyalinipennis Hine.
laticeps Hine.
osborni Hine.
parvulus Will.
productus Hine.
pygmæus Will.
sodalis Will.
sagittarius Macq.
tarsalis Adams.
atratus Hine.

LEPTIDÆ.

Xylophagus decorus Will.
gracilis Will.
nitidus Adams.
Xylomyia parens Will.
Arthroceras pollinosum Will.
Leptis palpalis Adams.
pleuralis Adams.
Chrysopila bella Adams.
flavibarbis Adams.
lucifera Adams.
Symphoromyia flavipalpis, Adams.
pachyceras Will.
plangens Will.

NEMESTRINIDÆ.

Hirmoneura flavipes Will.
Rhynchocephalus sackeni Will.
volaticus Will.

CYRTIDÆ.

Acrocera liturata Will.

BOMBYLIIDÆ.

Anthrax æmulus O. S.
agrippina O. S.
alto Tucker.
comparato Tucker.
cunculus O. S.
faustina O. S.
livia O. S.
moneta O. S.
sabina O. S.
Triplasius novus Will.
Heterostylum sackeni Will.
Anastœchus melanohalteralis Tucker.
fulvipennis Tucker.
Lordotus pulcherrimus Will.
Eclimus auratus Will.
lotus Will.
melanosus Will.
sodalis Will.
Desmatoneura argentifrons Will.
Aphœbantus carbonarius O. S.
conurus O. S.
cyclops O. S.

Desmatomyia anomala Will.
Dolichomyia gracilis Will.

THEREVIDÆ.

Psilocephala acuta Adams.
lateralis Adams.
occipitalis Adams.
Thereva anomale Adams.
crassicornis Will.

SCENOPINIDÆ.

Scenopinus electa Adams.
mirabilis Adams.

MYDAIDÆ.

Ecthypus townsendi Will.
luteolus Will.
Mydas abdominalis Adams.
scitulus Will.

APIOCERIDÆ.

Rhaphiomydas mellifex Towns.
xanthos Towns.

ASILIDÆ.

Leptogaster pictipes Loew. (Homotype.)
Stenopogon æacidinus Will.
gratus Loew. (Homotype.)
Triclis tagax Will.
Myelaphus rufus Will.
Dioctria albius Walker.
pusio O. S.
Cyrtopogon dasyllis Will.
dubius Will.
?gibber Will.
præpes Will.
Lasiopogon terricolo Johnson.
Holopogon snowii. (Cotype.)
Saropogon albifrons Black. (Cotype.)
combustus Loew. (Homotype.)
Deromyia perplexo M. A. C. (Cotype.)
Taractitus brevicornis Will.
Cophura? breviconis Will.
fur Will.
scitula Will.
Nicocles abdominalis Will.
rufus Will.
Nusa chalybea Will.
Dasyllis astur O. S. (Homotype.)
Laphria canis Will.
carbonarius Will.
ferox Will.
pubescens Will.
ruficauda Will.
ventralis Will.
vivax Will.
xanthippe Will.
Ommatius nigromaculosus Back.
Proctacanthus arno Towns.
Erax dubius Will.
jubatus Will.
latrunculus Will.
leucocomus Will.
similis Will.
stamineus Will.
Mallophora guildiana Will.
Promachus albifaces Will.
princeps Will.
rufipes Fabr.
Stenoprosopus arizonensis Will.
Neoitamus affinis Will.
distinctus Will.
Tolmerus delusus Tucker. (Cotype.)
callidus Will.
mesæ Tucker.
Philodicus rufipennis Hine.
Asilus angustifrons Will.
astutus Will.
Rhadiurgus leucopogon Will.

DOLICHOPODIDÆ.

Psilopodinus insularis Ald.
Diaphorus contiguus Ald.
dubius Ald.
flavipes Ald.
simplex Ald.
spectabilis Loew. (Cotype.)
Asyndetus fratellus Ald.
Chrysotus albipalpus Ald.
excisus Ald.
hirsutus Ald.
niger Ald.
picticornis Loew.
Eutarsus sinuatus Ald.
Parasyntormon occidentale Ald.
Sympycnus frater Ald.
Anepsiomyia linearis Ald.
Neurigona lateralis Say.
Thinophilus pectinifer Wheeler.
Thrypticus cupuliferus Ald.
singularis Ald.
Hydrophorus canescens Wheeler.
Liancalus hydrophilus Ald.
similis Ald.
Dolichopus albiciliatus Ald.
ciliatus Ald.
coloradensis Ald.
convergens Ald.
dakotensis Ald.
duplicatus Ald.
grandis Ald.
idahoeensis Ald.
kansensis Ald.
marginatus Ald.
obcordatus Ald.
occidentalis Ald.
plumosus Ald.
tenuipes Ald.
vigilans Ald.
willistonii Ald.
Herocostomus latipes Ald.
Paraclius filifer Ald.
venustus Ald.
Sarcionus lineatus Ald.
Pelastoneurus argentifer Ald.
kansensis Ald.

EMPIDIDÆ.

Drapetis flavida Will.
latipennis Mel. (Homotype.)
flaviceps Will. (Cotype.)
Paralhalassius aldrichi Mel.
Thinodromis inchoata Mel.
Hilara nugax Mel.
Rhamphomyia sociabilis Will.

PHORIDÆ.

Aphiochæta halictorum Mel. & Brues.
longifrons Brues. (Metatype.)

PLATYPEZIDÆ.

Callimyia venusta Loew.
Calotarsa calceata Snow.
ornatipes Towns.
Platypeza abscondita Snow.
cinerea Snow.
pulchra Snow.
tæniata Snow.
umbrosa Snow.
unicolor Snow.

PIPUNCULIDÆ.

Pipunculus fuscitarsis Adams.

SYRPHIDÆ.

Microdon lanceolatus Adams.
melanogaster Snow.
pallipennis Snow.
violens Towns.
xanthophilus Towns.
Callicera montensis Snow.
Nausigaster scutellaris Adams.
Chilosia chalybescens Will.
lucta Snow.
nigripennis Will.
tarda Snow.
willistonii Snow.
Chalcomyia ærea Loew.
Baccha bella Will.
Platychirus palmulosus Snow.
Melanostoma cœrulescens Will.
concinnum Snow.
kelloggi Snow.
Syrphus creper Snow.
disgregus Snow.
montivagus Snow.
pullulus Snow.
ruficauda Snow.
Xanthogramma habilis Snow.
Sphærophoria melanosa Will.
Brachyopa cynops Snow.
Volucella apicifera Towns.
Eristalis montanus Will.
Tropidia incana Towns.
Helophilus dychei Will.
Mallota albipilis Snow.
Criorhina lupina Will.
Spilomyia kahlii Snow.
Ceria snowi Adams.

CONOPIDÆ.

Conops bellus Adams.
fumipennis Adams.
semifumosus Adams.
gracilis Will.
sylvosus Will.
xanthopareus Will.
Physocephala affinis Will.
burgessi Will.
furcillata Will.
Zodion abitus Adams.
bicolor Adams.
parvum Adams.
pictulum Will.
pygmæum Will.
scapulare Will.
Stylogaster neglecta Will.
Dalmannis picta Will.
Oncomyia baroni Will.
modesta Will.
modesta, var. melanopoda Will.
propinqua Adams.
Myopa pictipennis Will.
pilosa Will.
plebeia Will.
tectura Adams.

TACHINIDÆ.

Phorantha occidentis Walk.
Alophora ænoventris Will.
Euscopolis dakotensis Towns.
Trichopoda subcilipes Towns.
Ceratomyiella conica Towns.
Rhinophora mexicana Towns.
valida Towns.
Anisia vanderwulpi Towns.
Euryceromyia robertsonii Towns.
Hypostena floridensis Towns.
indecisa Towns.
Hyalurgus johnsoni Towns.
Polidea americana Towns.
Eumyothyria illinoisensis Towns.
Leucostoma atra Towns.
?neomexicana Towns.
senilis Towns.
Clytiomyia flava Towns.
Xanthomelana atripennis Say.
Epigrymyia floridensis Towns.
geniculata Towns.
lucens Towns.
polita Towns.
robertsonii Towns.
Ginglymyia acrirostris Towns.
Plagiprospheryas floridensis Towns.
parvipalpos Van der W.
Plagia aurifrons Towns.
Siphoplagia anomala Towns.
Goniochæta plagioides Towns.
Chætoglossa picticornis Towns.
violæ Towns.
Pachyophthalmus aurifrons Towns.
floridensis Towns.
Pseudotractocera neomexicana Towns.

Belvosia vanderwulpi Will.
Malanophrys flavipennis Will.
Aphria ocypterata Towns.
Ocyptera argentea Towns.
Nemoræa hypantriæ Towns.
nigricornis Towns.
Gymnochæta ruficornis Will.
vivida Will.
Hyphantrophaga hyphantriæ Towns.
Exorista eudryadis Towns.
lagoæ Towns.
plagiordes Towns.
Euphorocera tachinomoides Towns.
Phorocera comstocki Will.
lophyri Towns.
puer Will.
Hypertrophocera parvipes Towns.
Frontina archippivora Will.
frenchii Will.
Sturmia nigrita Towns.
Masicera eufitchiæ Towns.
exilis Coq.
hemarides Towns.
Prospherysa promiscua Towns.
websterii Towns.
Vanderwulpia atrophopodoides Towns.
sequens Towns.
Tachina floridensis Towns.
spinulosa Towns.
Dæchæta harveyi Towns.
Neotractocera anomala Towns.
Paraphyto gilettei Towns.
Blepharipeza nigrisquamis Towns.
rufescens Towns.
Muscopteryx chætosula Towns.
Paradidyma braueri Will.
singularis Towns.
Atrophopalpns angusticornis Towns.
Phorichæta sequax Will.
Metopia leucocephala Towns.
Hilarella decens Towns.
elita Towns.
polita Towns.
Brachycoma chihuahauensis Towns.
intermedia Towns.
sarcophagina Towns.
Euthyrosopa petiolata Towns.
Gonia porca Will.
exul Will.
senilis Will.
sequax Will.
Spallanzania finitima Snow.
hebes Fal.
Eucnephalia gonoides Towns.
Amobia distincta Towns.
Archytas hystricoides Will.
Echinomyia dakotensis Will.
hystricosa Will.
Epalpus bicolor Will.
signiferus Wlk.
Jurinella exilis Towns.
soror Will.

DEXIIDÆ.

Hystrichodexia roederi Will.
Melanodexia tristis Will.

SARCOPHAGIDÆ.

Sarcophaga chætopygialis Will.
cimbicis Towns.
concinnata Towns.
helicis Towns.
leucaniæ Towns.
micropygialis Will.
Sarcodexia sternodontis Towns.
Sarcophagula imbecilla Van der W.

MUSCIDÆ.

Chrysomyia desvoidyi Hough.
Morellia nigriceps Bigot.
Hæmatobia alcis Snow.

BORBORIDÆ.

Aptilotus politus Will.
Limosina exigua Adams.
evanescens Tucker.
setigera Adams.

SCIOMYZIDÆ.

Tetanocera inopa Adams.
Sepedon ornatifrons Adams.
scapularis Adams.

SAPROMYZIDÆ.

Pachycerina dolorosa Will.
Sapromyza ingrata Will.
octovittata Will.
polita Will.
puella Will.
sororia Will.

ORTALIDÆ.

Rivellia brevifasciata Johnson.
Euxesta apicalis Will.

TRYPETIDÆ.

Spilographa concolor Van der W.
Trypeta occidentalis Snow.
Polymorphomyia basilica Snow.
Œdaspis minuta Snow.
montana Snow.
Rhagoletis zephyria Snow.
Eutreta longicornis Snow.
Eurosta fenestrata Snow.
reticulata Snow.
Xenochæta dichromata Snow.
Icterica fasciata Adams.
Tephritis dupla Cress. (Cotype.)
pallidipennis Cress. (Cotype.)
obscuripennis Snow.
variabilis Doane.
Euaresta bellula Snow.
latipennis.
Urellia conjuncta Adams.
flava Adams.

MICROPEZIDÆ.

Micropeza turcana Towns.
Calobata pleuritica Johnson.

DIOPSIDÆ.

Sphyracephala affinis Adams.
nitidus Adams.
pollinosus Adams.

EPHYDRIDÆ.

Notophila decoris Will.
Paralimna multipunctata Will.
obscura Will.
Discomyza dubia Will.
Discocerina obscura Will.
Ochtheroidea atra Will.
Ephydra pygmæa Will.
tarsata Will.

OSCINIDÆ.

Chlorops albifacies Adams.
appropinqua Adams.
bilineata Adams.
cinereipennis Adams.
halteralis Adams.
ingrata Will
liturata Adams.
parva Adams.
recurva Adams.
rubicunda Adams.
Hippelates splendens Adams.
Elachiptera bilineata Adams.
Oscinis collusor Towns.
incipiens Will.

DROSOPHILIDÆ.

Drosophila coffeata Will.
ornatipennis Will.
pallida Will.

AGROMYZIDÆ.

Agromyza lateralis Will.
sorosis Will.
Opthalmomyia lacteipennis Loew.
lobioptera Will. (Cotype.)

HIPPOBOSCIDÆ.

Trichobius dugesii Towns.

NYCTERIBIIDÆ.

Nycteribia antrozoi Towns.

AFRICAN DIPTERA.

Systropus snowi Adams.
Promachus flavibarbis Adams.
negligens Adams.
solus Adams.
apicalis Adams.
Sisyrnodites major Adams.
nigrifimbriis Adams.
Melanostoma bituberculata Adams.
Eristalis communis Adams.
æqualis Adams.
dissimilis Adams.
longicornis Adams.
Hineia flavipes Adams.
Pasacompsomyia houghi Adams.
splendida Adams.
vesticulis Adams.
Tipula velusa Doane.
nincineta Doane.
spectabilis Doane.
streptocera Doane.
sulphuræ Doane.

SUMMARY OF ORDERS.

	Species.
Diptera	510
Hymenoptera	215
Lepidoptera	97
Hemiptera	38
Orthoptera	11
Neuroptera	1
Total number of species	872

NOTES ON KANSAS MAMMALS.

By D. E. Lantz, Biological Survey, Washington, D. C.

A MONOGRAPH on the hares and rabbits of North America has been prepared by Mr. E. W. Nelson, of the United States Biological Survey, and will soon be published. The examination of specimens collected in Kansas shows that two hitherto unreported races of rabbits occur there. They are *Sylvilagus floridanus similis* and *Sylvilagus auduboni baileyi*. These make the total number of forms of rabbits known from the state seven, as follows:

Lepus campestris Bachman. White-tailed Jack-rabbit. Occurs throughout the northern half of the state, and in the western part, perhaps south of the Arkansas river. The American Museum, New York, has specimens from Garden City.

Lepus malanotis (Mearns). Black-eared Jack-rabbit. Occurs throughout the state, but is not common in the extreme northeastern part; abundant in the western part.

Sylvilagus floridanus mearnsi (Allen). Mearn's Cottontail. Of the cottontails, this form is the most widely distributed in the state. Mr. Nelson examined specimens from Lawrence, Manhattan and Onaga, as well as from Washington county. It probably occurs in the valley of the Kansas river west to the limit of trees.

Sylvilagus floridanus alacer (Bangs). Oklahoma Cottontail. Occurs in southern Kansas. Specimens were examined from Garden Plain, Belle Plaine and Wichita.

Sylvilagus floridanus similis Nelson. Nebraska Cottontail. Specimens from Long Island, Kan., were referred to this form, the type of which came from Valentine, Neb.

Sylvilagus auduboni baileyi (Merriam). Wyoming Cottontail. This form of the small plains cottontail has been taken at Wa Keeney and Pendennis.

Sylvilagus auduboni neomexicanus Nelson. New Mexico Cotton-tail. Specimens in the Biological Survey collection taken at Kinsley and at Kiowa were formerly referred to *Lepus* [*Sylvilagus*] *arizonæ minor*, and were so entered on my list of Kansas mammals in former papers read before the Academy. They have been assigned by Mr. Nelson to this new form.

Nyctinomus mexicanus Saussure. Mexican Free-tailed Bat.

The specimen of free-tailed bat collected at Manhattan by Dr. C. P. Beachey and presented by him to the Washburn College museum, was forwarded to the Biological Survey in February, 1907, and identified there as the Mexican species. It was submitted also to the judgment of Mr. Gerritt S. Miller, of the United States National Museum, who confirmed the identification.

The three additions herein reported make the total number of forms of native mammals of Kansas eighty-eight.

THE GERM-PLASM HYPOTHESIS OF WEISMANN UNTENABLE.

By L. C. Wooster, Department of Biology and Geology, State Normal School, Emporia.

MANY scientists who have approached biology from the side of mathematics, physics and chemistry have injected the certainties of physical science into their explanation of the phenomena of life, a variable. In the foremost rank of philosophical biologists stands August Weismann, who is author of the most ingenious materialistic hypothesis offered to explain heredity and ontogeny. Weismann claims in his hypothesis that a very precious portion of germ-plasm, peculiar in its qualities to each species, is handed on from generation to generation, bearing impressed on the matter composing it the characteristics of parents to offspring. Shielded from rude contact with the external world, the qualities of the plasm change but slowly, just enough to carry forward the work of evolution.

Filled with admiration for the great atomic theory, in which the qualities of the molecule are said to depend upon the kind, number and arrangement of the atoms composing it, Weismann imagined that the germ-plasm must consist of myriads of tiny aggregations of molecules, which he decided to name biophors, or bearers of the qualities of life. These biophors must equal in number of kinds the total number of qualities exhibited by all plants and animals, one biophor for each quality. As there are many millions of such qualities, the disciples of Weismann match them with billions of biophors in each germ-cell.

Each biophor, Weismann imagined, could assimilate food, grow and divide so the total number would equal all the needs of all the cells of each individual. Weismann further imagined that the biophors became united into groups which he named determinants, there being one determinant for each cell of the body, except the germ-cells. The germ-cells must have all the different kinds of determinants needed by the developing plant or animal. But these determinants of the germ-cells could also absorb food, grow and divide as well as the biophors, so there would always be enough of them for all the cells of the body, no matter how many they might be. The determinants were thought to be somewhat piggish in their dispositions so they would struggle with one another for food and oxygen, and some would get more than their due share and grow faster and become dominant, while others would starve and

be recessive. These are certainly strange propensities for matter to exhibit.

Weismann has never seen a biophor nor a determinant, but imagines them to exist, just as the chemist imagines atoms to exist, never having seen them, because they enable him to offer a solution to a difficult problem. Weismann fails to note one serious difference between the condition of atoms in a molecule and that of molecules in a biophor or a determinant. Atoms are probably held by powerful polar forces to a definite arrangement in the molecule; but the molecules of biophors and determinants in a fluid, colloidal mass like protoplasm can have no such fixed arrangement. The few kinds of molecules in the rapidly multiplying chromatin granules or microsomes are in a constant state of flux of construction and destruction during the lifetime of every protoplasmic cell. Even if all proteids were crystalloids, this instability of molecular arrangement but proves the presence of an influence, such as life can exert, that can build or unmake crystals with a rapidity and ease unknown in all other crystalline substances.

Nutriment and oxygen must flow in a steady stream into the living cell, energy must be continuously liberated for the activities of the protoplasm, and useless matter must be as continuously excreted, or the cell dies. All this would seem to prove beyond question that the many kinds of molecules, their definite and stable arrangement in the biophors and determinants, required to give a physical basis to the germ-plasm hypothesis, are absent from living protoplasm. No known law of chemistry, no known law of physics, sanctions the statement that the arrangement of the molecules and supermolecules in colloidal matter like protoplasm can and does produce combinations possessing the characteristics of the biophors and determinants claimed by Weismann and his disciples.

But some disciple of Weismannism may say that the qualities exhibited by all the kinds of plants and animals may inhere, nevertheless, in some unknown way in the matter composing their bodies. Darwin and many others beside Weismann have imagined that this might be true. What are the possibilities for matter to play an important part in heredity? The qualities of the parents go in some way to the offspring. Either matter must possess and carry them or we must make an entity of that so-called quality of matter, termed life, and let it carry the inherited qualities. The second horn of the dilemma is the one which a rapidly increasing number of biologists have decided to take, and even Weismann admits that life may be the bearer of inherited characteristics from parents to

offspring (Evolution Theory, vol. II, page 369), but naturally prefers his own hypothesis.

Knowing the characteristics of life and the qualities of matter by personal experience and observation, we ought to reach a large measure of certainty as to which is the bearer of inherited qualities by making a careful study of the process of reproduction in plants and animals. The remainder of this paper will be devoted to a presentation of this process and to showing wherein the activities of organisms transcend all known powers and qualities of matter and energy, but are germane to a third entity, life, as capable of definition as are the other members of this triumvirate.

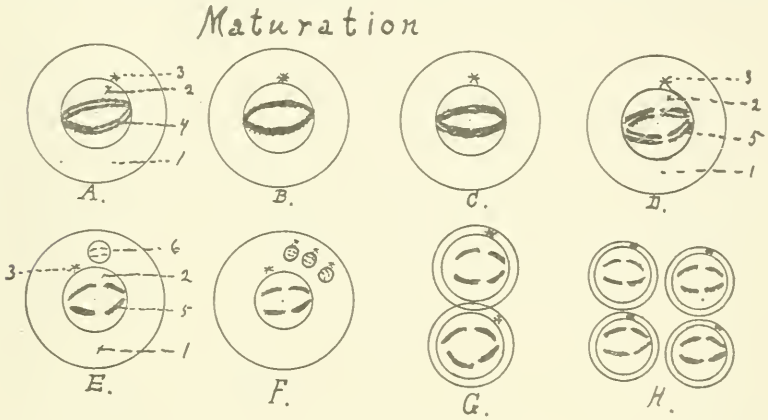
MATURATION.

A to *H*.—All protoplasmic cells of higher plants and animals consist of protoplasm of several kinds in form and function. In the outer part of the cell is the cytoplasm, *A*-1, concerned in the various processes of absorption, nutrition and excretion; and near the center of the cell, the nucleus, 2, possessing control over cell-conjugation and cell-division. The cytoplasm consists of a reticulum or spongioplasm in which, in plant-cells, are embedded numerous and variously colored plastids, nutritive in function, a fibrillar plasma which influences the process of development, and a structureless fluid, the hyaloplasm. Near the nucleus is an interesting body, the centrosome, 3, which plays a very important part in nuclear division in most animal cells and in the lower plants. The nucleus consists of a structureless fluid, the nucleoplasm, somewhat different from hyaloplasm, a reticulum holding one or more nucleoli of unknown use, a granular material which stains deeply, the chromatin, and fine fibers which for the most part do not stain at all, the linin.

At the beginning of the process of maturation the chromatin granules, sometimes called chromomeres or microsomes, arrange themselves, as though in obedience to some word of command, along two crinkly threads of linin. In the diagrams which illustrate this paper no attempt has been made to represent the actual appearance of these threads under the compound microscope, nor has any attempt been made to show the spindle of linin threads, which does such important work in cell-division. The two threads of linin along which the chromomeres have arranged themselves are the spiremes, 4.

It should be remembered at the outset that cytoplasm is derived from preëxisting cytoplasm, that nucleus is derived from preëxisting nucleus or nuclei; one does not make the other when it is ab-

sent and soon dies without it. Also, centrosome arises by division of centrosome, and plastid by division of plastid. The chloroplastids and chromoplastids are derived from leucoplastids. Evidently these forms of protoplasm would each occupy less and less space by self-division did they not absorb and assimilate nourishment and become more and more inactive did they not continuously release fresh supplies of energy from energy-containing foods for



the activities of the protoplasm; but all this is merely additional proof that in studying these forms of protoplasm we are studying the various manifestations of a power that is something more than that possessed by matter and an intelligence that is greater than that manifested by unharnessed energy.

The two spirem threads, shown in *A*, soon move together, chromomere of one moving to a chromomere of the other.* The result is a single spirem shown in *B*. This conjugation persists in the case of *Lilium canadense* for from two or three days to a week. What happens while the two threads are in conjugation, what influences cross from one chromomere to the other, no one knows. The best observers believe that the conjugating chromomeres of the two spirems come from different parents, those of one spirem from one parent and those of the other spirem from the other. During the lifetime of the individual producing the mother germ-cell, the chromomeres remained distinct, and all the cells of her body were under the control of those chromomeres whose life powers were dominant, according to the Mendelian law.

After close union for several days the spirem splits, as shown in *C*, but no one knows whether the division plane corresponds to the

*This description follows somewhat closely that of chromosome reduction in *Lilium canadense* by Charles E. Allen, University of Wisconsin, in *Botanical Gazette*, June, 1904; and of Strasburger and Lang, 1908.

previous plane of union or not. Then in a short time the two spirems divide transversely, shown in *D*, into segments termed chromosomes.

In the mother germ-cells of many species of plants and animals, the two spirem threads divide transversely, before union, into chromosomes. These unite. chromosome with chromosome, chromomere wifh chromomere, remain in close union for several days, and then separate, as do the spirem threads. From either method of union and division there always results a definite number of chromosomes peculiar to the species. In this case the number eight has been taken, shown in *D*. Every species of plant and animal has its peculiar number. In certain red algæ there are 40 chromosomes; in sharks, 36; in certain gasteropods, 32; in the salamander, trout, mouse, fern, lily and man, 24; in the sagitta, ox, guinea-pig and onion, 16; in the grasshopper, 12; in a liverwort, 8; and in some of the nematodes, 8, 4 or 2.

The mother egg and mother sperm-cells of the same species of plant or animal have the same number of chromosomes in their nuclei. These mother germ-cells differ in appearance chiefly in their form and in the amount of cytoplasm they contain, the mother egg having even many thousand times as much cytoplasm as the mother sperm.

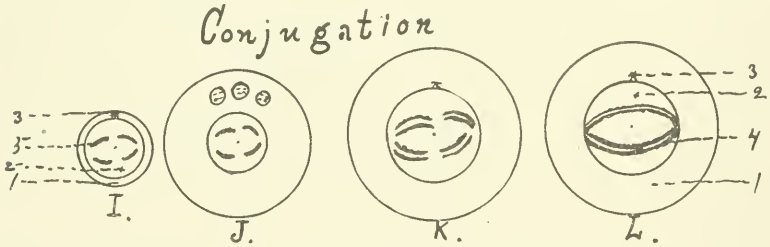
In *animals* before the egg and sperm are ready to conjugate the mother egg and the mother sperm nuclei must each reduce the number of chromosomes one-half. In the mother egg-cell, as shown in *E* and *F*, the nucleus has divided unequally by mitosis and four of the chromosomes have passed out into the cytoplasm with a small part of the nucleoplasm, becoming the first polar body, *E*-6. Actuated by a very primitive instinct, the chromosomes of the nucleus and the polar body split, and each nucleus divides by mitosis, the former unequally as before, and the latter equally. The result is shown in *F*. In a similar way the mother sperm-cell divides by mitosis into daughter sperm-cells and these into granddaughter sperm-cells or sperms, again making four resultant cells according to the primitive instinct. It will be noted in *G* and *H* that the mother sperm-cell divided equally, making four functional sperms, while the mother egg-cell, by dividing unequally, produced only one functional egg. The three polar bodies may perhaps assist in organizing the cytoplasm for the work of preparing nutrition for the embryo.

In *plants* the process of maturation is the same as in animals, except that the resulting cells are not eggs and sperms, but *spores*,

which must germinate and produce another organism whose cells have half the normal number of chromosomes, and which finally produces eggs and sperms in peculiar organs. Plants which produce spores of equal size are isosporous, and plants which produce spores of unequal size are heterosporous, the large spores being named megaspores and the small spores microspores. The liverworts, mosses and common ferns are isosporous; and marsilia, selaginella, the pines and spruces, and all our common flowering plants produce spores of different sizes and are therefore heterosporous.

CONJUGATION.

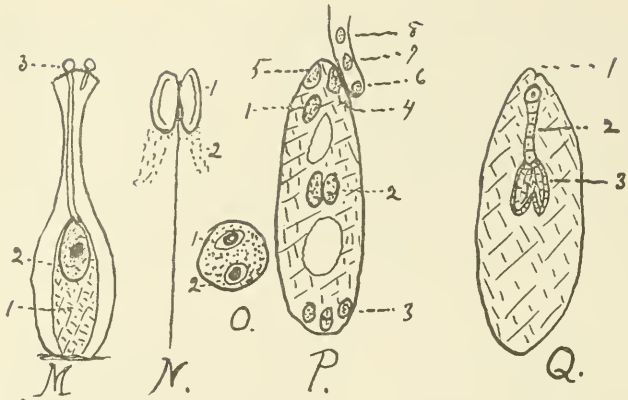
I to *L*.—On the conjugation of one of the sperm-cells with the egg-cell, complete fusion of the cytoplasm and nucleoplasm takes place, but the chromosomes do not unite but continue distinct during myriads of succeeding cell divisions till the next period of maturation. The three polar bodies of the egg-cell disappear as does also its centrosome, the centrosome of the sperm-cell officiating



in the cell divisions. It will be noted in *K* that the fertilized egg has eight chromosomes, and that finally these unite to form two spirems, shown in *L*, at the beginning of the next maturation after myriads of cell divisions. The process of conjugation of eggs and sperms is the same in plants and animals.

PLANT FERTILIZATION AND EMBRYOLOGY.

M to *Q*.—It has long been known that the spore-containing organs of plants are usually modified leaves. Gray long ago taught that the simple pistil is a leaf so modified that it forms a closed chamber or cell in which the ovules (megasporangia) are developed along its united margins. We know that the embryo-sacs of the ovules are megaspores, that the ovules are megasporangia, and that the pistils are megasporophylls. In like manner the stamens, usually modified leaves, are now called microsporophylls; the anthers, microsporangia, and the pollen grains, microspores. In diagram *M*, 1 is the nucellus containing the embryo-sac, 2; and 3 is a pollen



Plant Fertilization & Embryology

grain germinating on the stigma. *N* represents a stamen with its filament, anthers and pollen. *O* is an enlarged pollen grain or microspore. Among mosses when certain spores germinate there are developed plants of considerable size with rhizoids, stems, leaves and sperm-producing bodies, the antheridia; and other spores develop into similar plants with egg-producing organs, the archegonia. Such organisms are known to the botanists as the male and female gametophytes; and among mosses they are the chief food-elaborating structures. But among flowering plants, the cottonwood, for example, the sperm- and egg-producing gametophytes have degenerated till only a few cells remain, and the organisms are entirely dependent on food stored in the spore by the parent sporophyte. The germinating microspore of the cottonwood shows only two or three gametophyte cells, viz., a tube-producing nucleus, *O*-2, and a mother sperm-cell, *O*-1.

It will be remembered that when the animal mother germ-cells mature (see diagrams *F* and *H*), one functional egg nucleus is produced and four functional sperms; but the botanist has found that in plants these germ-cells are all spores. Among mosses and common ferns all the spores are equal in size and each may develop, so far as the botanist knows, into a male or a female gametophyte; or in some species the spore develops into a gametophyte which bears both kinds of sexual organs, the antheridia and archegonia, containing at maturity respectively the sperms and eggs. In marsilia, selaginella, the gymnosperms and the angiosperms, the spores produced by the maturing mother germ-cells are of unequal sizes, and are therefore named microspores and megaspores. The

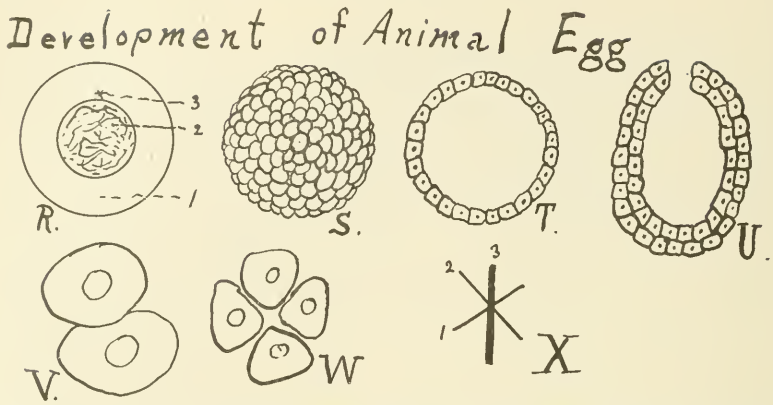
microspores always produce, on germination, male gametophytes, and the megaspores female gametophytes.

In the megasporangium (ovule) of the canna four megaspores develop, according to the ancient instinct, but only one is functional. In most angiosperms, including the cottonwood, only one megaspore reaches any size. This megaspore, shown in *P*, contains at first only one nucleus. This nucleus soon divides in rapid succession till eight nuclei are formed, four at each end of the megaspore or embryo-sac Then one of each four moves to the middle of the sac and there the two fuse to make the polar nucleus, *P*-2. Of the three nuclei which remain near the micropylar end of the sac, 4 and 5 are synergids or helpers, and 1 functions as egg. The three nuclei at the distal end of the sac are the antipodal nuclei, 3, and are believed to represent a few of the cells of the degenerate female gametophyte. Possibly the synergids, 4 and 5, represent an archegonium.

When the pollen (microspore) tube reaches the vicinity of the embryo-sac, the tube nucleus, 6, disintegrates, and the mother sperm nucleus divides into two sperms, 7 and 8. Synergid 4 disappears and one sperm nucleus, 7, passes into the sac, makes its way to the polar nucleus, 2, and unites with it, forming the endosperm nucleus which has charge of providing nourishment for the embryo. Sperm nucleus 8 enters the sac and unites with the egg. The fertilized egg at once takes nourishment and divides repeatedly. True to an ancient instinct, it so divides at first as to make a filament, as is still the only or chief method of the algæ. This filament, the suspensor, *Q*-2, serves to push the rapidly growing embryo, *Q* 3, into the food stored in the endosperm. *Q*-1 represents the location of the micropyle. How can any one compel his mind, even though it be steeped in physics and chemistry — how can any one believe that this wonderful process of fertilization and development is merely a function of matter?

DEVELOPMENT OF THE ANIMAL EGG.

R to *X*.—The fertilized animal egg consists usually of a large amount of cytoplasm, *R*-1, a nucleus which contains chromatin, *R*-2, which becomes organized into the normal number of chromosomes when the cell is preparing to divide, and a centrosome, *R*-3. The fertilized egg-cell of animals divides and redivides in a fashion peculiar to animals. The first divisions are in the three planes at right angles to one another, *X*-1, 2, 3, making first two cells, *V*, four cells, *W*, then eight, sixteen and thirty-two cells arranged in a solid sphere or morula. As the next step in development a cavity ap-



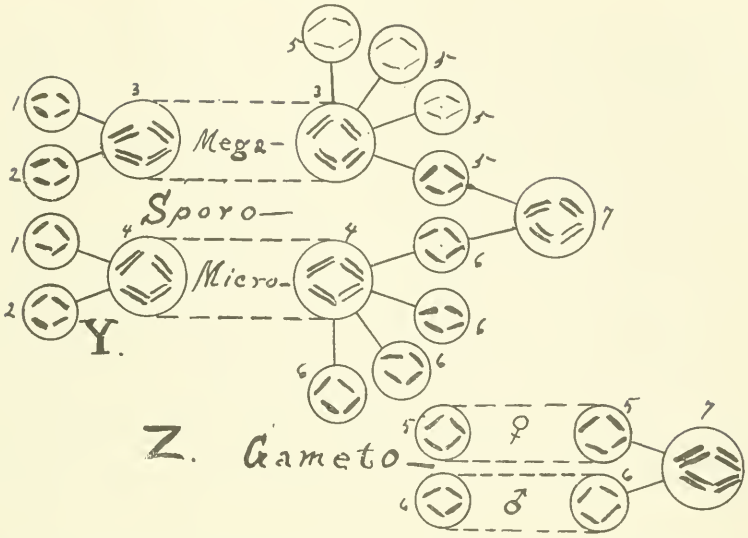
pears in the solid sphere, the cells multiply rapidly and the embryo becomes a blastula, *S* and *T*. The third stage in development, shown in section in *U*, is that known as the gastrula, produced in various ways, but usually by the invagination of one side of the blastula, due to unequal cell division and growth. The gastrula may be likened to a two-walled cup with a small mouth. In some form or another all complex animals pass through this stage of development, as well as the morula and blastula stages. After the gastrula stage is reached animal bodies of the highest complexity are produced by a series of simple and compound invaginations and evaginations, tubular or furrow in shape and many times repeated, involving the ectoderm, entoderm and mesoderm.

SUMMARY OF REPRODUCTION IN PLANTS AND ANIMALS.

Y and *Z*.—Diagram *Y* illustrates reproduction in animals, but *Y* and *Z* are both required to illustrate the same in plants. It should also be noted that in all cases when egg and sperm unite it cannot be foretold whether the resulting individual will in the case of animals produce eggs or sperms, or in the case of plants produce spores that will develop into male or female gametophytes.

For *animals*, in diagram *Y*, we will suppose that two sperms, 1, 1, unite with two eggs, 2, 2, each cell having a nucleus with four chromosomes; the resulting fertilized eggs, 3, 4, will each have eight chromosomes. Let us suppose that the fertilized eggs produce two individuals, one female, 3, 3, and one male, 4, 4. When the female produces one functional egg, 5, and the male four functional sperms, 6, 6, 6, 6, the cycle will be complete.

For *plants*, in diagrams *Y* and *Z*, the process of reproduction is the same as that indicated in diagram *Y*, except that one functional spore capable of developing into a female gametophyte is produced,



and four functional spores capable of producing male gametophytes are produced. In most of the higher plants the former is a megaspore and the latter are microspores. The cycle for plants is completed when the megaspore germinates and produces a female gametophyte, 5, 5, which bears an archegonium containing, when it matures, an egg, and the microspores germinate and develop into male gametophytes, 6, 6, bearing antheridia containing at maturity the sperms; 7 and 7 are merely fertilized eggs, like 3 and 4 at the left in diagram *Y*, the upper 7 for animals and the lower 7 for plants.

Weismann invented his hypothesis respecting the continuity of germ-plasm to combat the hypothesis of Lamarck that acquired characters are inherited. Weismann contended that the cells of the body may be grouped into two classes, the soma- or body-cells and the germ-cells. He declared that the soma-cells might be modified by use, but such modifications could not be transmitted to offspring, for the germ-cells would remain unmodified.

This ingenious hypothesis was at once attacked by the Lamarckians and Neo-Lamarckians, and Weismann added biophors and determinants to his germ-plasm to strengthen his position.

Many mathematical biologists have accepted Weismann's views respecting heredity, and have declared that Lamarckianism is dead. If they are right, it is very strange that the disciples of Weismann are obliged to repeat their declaration so frequently.

The two main assertions of Weismann have not been proved.

He has not proved that germ-plasm is handed on from generation to generation little changed, nor has he shown that life is a quality of matter due to the number, kinds and arrangement of supermolecules called biophors and determinants.

It is well known, on the contrary, that germ-plasm and all other forms of protoplasm are undergoing continuous change through oxidation and repair of waste and through growth and division of cells, millions of times repeated in the case of the germ-cells, especially. Each plant and animal produces during its lifetime, if it matures, thousands up to many millions of germ-cells. The plasm with which each organism began would be but as a drop of water to a barrelful compared with what it sends out. Nor can life be merely a quality of matter due to the number, kinds and arrangement of supermolecules in a colloidal mass of matter, containing few kinds of molecules and undergoing constant change through nutrition, oxidation and excretion.

Such a claim for matter is so remarkable that a full statement of its significance will show best how foreign such qualities are to the matter of science and how appropriate they are to matter of the imagination. Let us consider four facts universally known to be true of organisms: (1) Since there are about one million species of plants and animals on earth to-day, and at least twenty-five million have existed in prehistoric times; (2) since each species is represented by millions of individuals, and has in past times been represented by millions more, each with its personal characteristics; (3) since each complex organism has thousands up to billions of cells, which differ in their powers and functions; (4) since each organism varies from year to year, and each species varies from century to century: It follows that figures are entirely inadequate to express the number of combinations and variety of combinations of molecules and supermolecules that would be needed to provide a setting for these qualities, were such attributes possible to matter.

The molecules of lifeless matter may be shifted and rearranged at pleasure without showing in the least the qualities of living matter; and no chemist or physicist has yet been able to make even an organic molecule like starch from carbondioxid, water and sunshine, still less a supermolecule with life.

All true biologists must claim that a peculiar entity which he knows as life bears the myriad and variable qualities such as living organisms possess, and must sharply differentiate the powers of life from those of energy and matter. Matter alone, nor matter with energy, certainly cannot manage such complex reproductive processes as those we have just studied.

The writer of this paper believes that Weismann's hypothesis is fundamentally wrong. Life, not matter, bears inherited qualities. Life manages matter through energy for its own convenience while developing its powers. Life as we know it is not bounded by cell-walls but pervades the whole body in a general way, and provides for itself special lines of communication along nerve-fibers to control those parts which do work instinctively. The generative cells and the conscious powers are in especially close communication.

The first activity of the first organism must have been consciously performed. The nature of life is and was such that repetition bred habits, and habits persisted in for many generations became instincts and were then hereditary.

This body of instincts recruited from habits became in the simple and more complex organisms a great conserving influence, and prevented sudden change of method of living and doing. Body-building instincts, as all know, can seldom be entirely obliterated. The human embryo still has gills. Such instincts can be buried beneath better ones, but can seldom be destroyed.

So conscious activities in highly organized beings like man can do little to modify the growth of the body in its more primitive parts, and are powerful chiefly in directing the growth of the parts lately acquired, like the mammalian brain and the voluntary muscles. But all parts of the body can be modified through the effects of use and disuse, for a persistence on the part of life of the use or disuse of tissues and organs recently or long established, because of a permanently changed environment or habit of life, continued for many generations, has certainly resulted in a modification of the body-building instincts. Animals found in caves are minus eyes but possess greatly enlarged touch organs. Water-animals that have acquired the land habit, like the lung fish; snakes that have lost their limbs through disuse; land animals, like the whale and seal, that have become adapted to the water life, and many series of fossil forms, all prove the potency of life to change the body when the need arises. The germ-cells are intimately connected with the soma cells in a general way by a sort of wireless telegraphy and specifically by means of countless nerve-fibers. This intimate association is shown unmistakably in young animals when the removal of a portion of the germinal tissues is followed by a great change in the development of the rest of the body, and by the great influence of the mind and body over the germ-plasm during every moment of the maturing life of the individual.

But where is your certainty that life has made and can make such body-transforming volitions? asks, in substance, a leading

zoölogist. These body-transformations of lower organisms have not been established by man-made mutilations; environments cannot of themselves produce inheritable modifications; the only efficient agent, therefore, is the life within the organism. As to certainty, so long as life is a variable, so long as life is a law unto itself, we must reply that certainty in the very nature of the case cannot exist. He alone who has within himself the spirit of discernment of what life has done can exercise the spirit of prophecy and foretell what life may do; he must be in very truth a biologist, and not be heavily tinctured with the formalism of the mathematician, the physicist and the chemist.

Whether the inheritance of acquired characters shall result in an orthogenetic, saltatory or rameal evolution of a race depends on the many small, conscious choices of many lives, made in few or many generations, to better meet the conditions of a changing environment.

In conclusion, then, it is necessary merely to reaffirm what has been several times stated in this paper. The Weismann hypothesis is clearly untenable, for it is life that carries and transmits inherited characters and that compels matter to obey it through energy.

ADDITIONS TO THE LIST OF KANSAS COLEOPTERA FOR 1908.

By W. Knaus, McPherson.

THIRTY-EIGHT species and varieties of Coleoptera were added during 1908 to the list of species found in Kansas. Of these, two were described as from Kansas by Maj. T. L. Casey, but without definite location; two were collected in Cheyenne county, near Wheeler, by M. L. Slagle; thirteen were taken in Douglas county and are in the University collection, and the others were collected by myself in various parts of the state, or were recognized from material worked out in *Brachynus* by H. C. Fall, of Pasadena, Cal., and in the *Sphenophorus* by F. H. Chittenden, of Washington, D. C.

1—313 Bembidium nititidum Kirby. One specimen, Wheeler, Cheyenne county.
2— — Diplochila clivens Csy. (Casey.)
3—963 Brachynus janthinipennis Dej. Englewood.
4—976 Brachynus ballistarius Lec. One specimen, McPherson.
5—981 Brachynus phæocerus Chd. One specimen, McPherson.
6—978 Brachynus cordicollis Dej. Southeast Kansas.
7—1243 Laccophilus decipiens Lec. One specimen, Wheeler, Cheyenne county.
8— — Connophron triviale Csy. McPherson.
9— — Symbiotes sp. Two specimens under bark of maple tree, November 5. McPherson.
10— — Cerylon clypeale Csy. (Casey.)
11—3342 Læmophlœus pusillus Sch. Found in wheat screenings, November. McPherson.
12—3402 Tryphillus humeralis Kirby. Topeka. Popenoe.
13—3441 Trogoderma sternale Jayne. One specimen, Lawrence.
14—3442 Trogoderma orantum Say. One specimen, Lawrence.
15—3452 Cryptorhopalum triste Lec. Lawrence.
16—3604 Saprinus ciliatus Lec. Gove county.
17—3655 Acritus acaroides Mers. Central Kansas.
18—3717 Epureæa scaphoides Horn. One specimen, Lawrence.
19—3722 Stelidota geminata Say. Lawrence and Onaga.
20—3723 Stelidota 8-maculata Say. Lawrence.
21—3724 Stelidota strigosa Gyll. Lawrence.
22—3841 Tenebroides sinuata Lec. Lawrence.
23—3843*a* Tenebroides nigrita Horn. Lawrence.
24—3844 Tenebroides lugosipennis Horn. One specimen, Salina.
25—3857 Monotoma fulvipes Melsh. One specimen, Lawrence.
26—3866 Hesperobænus rufites Lec. Lawrence, and Morton county.
27—3946 Stenelmis linearis Zimm. Lawrence.

28—3950 Stenelmis 4-maculatus Horn. Lawrence.
29—5061 Attalus rufiventris Horn. Coldwater, June.
30— —— Cyclocephala sp. One specimen, Edwards county.
31—6441*a* Hyperplatys, var. nigrellus, Hald. Bred from persimmon branches, Wilson county.
32—6951 Disonycha glabrata Fab. One specimen, Coldwater, June.
33—7803 Mordellistena biplagiata Helm. One specimen, Coldwater, June.
34—8469 Macrops solutus Boh. Coldwater, June. Swept from aquatic plants.
35—9004 Sphenophorus gagatina Gyll. East Kansas.
36— —— Sphenophorus madis Chit. Medora.
37—9007 Sphenophorus germari Horn. West Kansas.
38— —— Sphenophorus destructor Chit. Medora.

V.

MISCELLANEOUS PAPERS.

1. "Railroad Rates from an Engineering Standpoint."
   By Prof. B. J. Dalton, University of Kansas, Lawrence.
2. "On the Care of Mammal Skins Kept for Museum Purposes."
   By L. L. Dyche, University of Kansas, Lawrence.
3. "Notes on the Photography of Wild Birds."
   By J. B. Parker, State Agricultural College, Manhattan.
4. "Cancer: Thoughts On."
   By J. M. McWharf, Ottawa.
5. "Notes on the Gila Monster."
   By Bernard B. Smyth, Topeka.
6. "The Medullary Ray as an Element of Strength in Structural Timber."
   By Frank E. Jones, University of Kansas, Lawrence.
7. "Darwinism and Experimentation in Botany."
   By D. T. MacDougal.

RAILROAD RATES FROM AN ENGINEERING STANDPOINT.

By Prof. B. J. DALTON, Dallas, Tex.

OWING to the agitation that has been going on for some time relative to the reduction of railroad rates, the speaker thought it might be interesting to discuss the question from an engineering standpoint.

First, it is conceded that every man is entitled to a fair rate of interest on money that he may invest in any enterprise, and when that money is invested in railway property, and the railway is economically and judiciously managed, he is entitled to adjust the rates so as to pay a fair profit on the investment.

In order to make an intelligent comparison of the railroads of the country, the Interstate Commerce Commission has divided the United States into ten groups, according to the territory through which they run, since in this manner the density of the population, the topography of the country, and the character of the industries served by the railroads may be taken into account. Then all the roads operating under about the same conditions are placed in one group.

Group VIII, in which we are located, comprises Missouri, Arkansas, Kansas, Oklahoma, the south two-thirds of Colorado, the northeast corner of New Mexico, and the extreme northwest point of Texas.

We will first show how the rates in this group compare with those of the whole United States, and finally how the rates in Kansas compare with those of all the roads in group VIII.

Plate I shows graphically the revenue per passenger per mile in the United States, and in group VIII, from 1890 to 1895, inclusive. It will be observed that for the United States this rate has decreased gradually from 2.167 cents to 1.962 per mile. The curve for group VIII practically runs parallel to the curve for the whole United States and on an average of two-tenths of a cent higher.

This plate also shows the average rates on three of the principal roads in the state of Kansas—the Union Pacific, the Chicago, Rock Island & Pacific, and the Atchison, Topeka & Santa Fe—compared with all the roads in group VIII. It will be observed that for the first few years after 1900 the rates on the individual roads were a

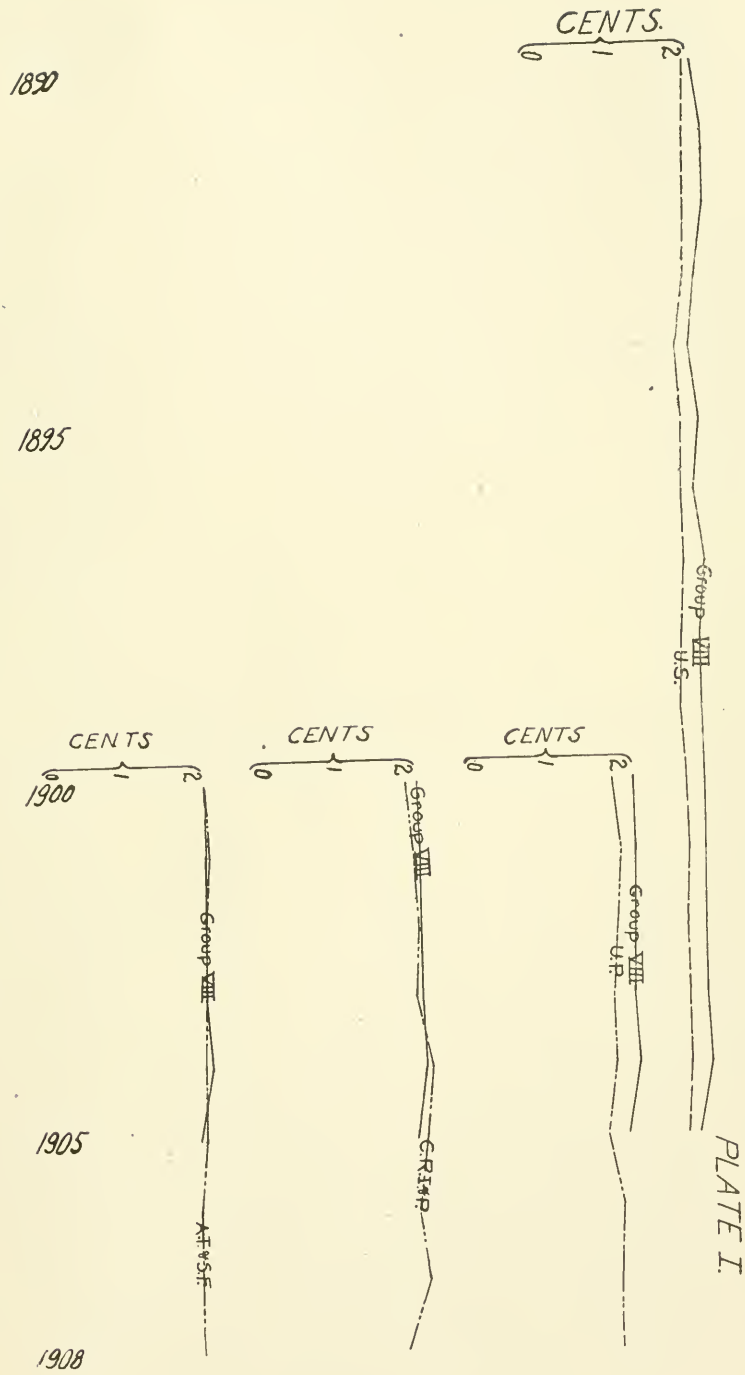
trifle higher than the average rate on those in group VIII, but that since 1905 they have decreased rapidly until, with the report for the year ending June 30, 1908, the average passenger rate was about two cents per mile.

Plate II shows the revenue per ton per mile for all the roads in the United States, and also for those in group VIII. From it one can see that the average for the United States has dropped from ninety-five one-hundredths of a cent per ton per mile, the rate in 1890, to seventy-six one-hundredths of a cent per ton per mile in 1905. Group VIII is about two-tenths of a cent higher, and this rate is about one-twentieth what it would cost to haul by wagon.

Now, comparing the Union Pacific, the Rock Island, and the Santa Fe, in this state, with group VIII, we find about the same conditions existing in the freight rate as in the passenger rate, namely, that the freight rate on the individual roads is about two-tenths of a cent higher than the average for the group until 1905, after which time it begins to drop, and at the present is about ninety-five one-hundredths of a cent per ton per mile. This certainly looks as if it were cheap enough.

We will now turn to the dividends paid on the stock from the earnings due to the above rates. Plate III shows the average dividends paid on the stock of all the roads in the United States, and also in group VIII, beginning with the year 1890 and ending with 1905. From this it will be seen that the railroads have paid dividends of from 4 per cent. to 6 per cent. on all stock since 1901. Taking the same three roads in Kansas, we find that from June 30, 1907, to June 30, 1908, the Santa Fe paid 5½ per cent. on common and 5 per cent. on preferred, the Union Pacific 10 per cent. on common and 4 per cent. on preferred, and the Rock Island 5¼ per cent. on common.

These figures do not give the actual percentage on the investment, for the reason that the dividend is declared on the face value of the stock and not on the market value. For instance, the present market value of Santa Fe common is about 97½, and preferred 102½; Rock Island common is 24, preferred 60; Union Pacific common is 180, preferred 95; so that if a man buys Rock Island common at 24 and receives 5½ per cent. dividend, he is actually receiving 22.9 per cent. interest on his investment, but if he buys Union Pacific at 180 and receives 10 per cent. dividend, his actual rate of interest will be 5½ per cent.


CENTS.
0
1
2
1890
1895
Group VIII
U.S.
CENTS
0
1
2
Group VIII
U.P.
CENTS
0
1
2
Group VIII
C.R.I.&P.
CENTS
0
1
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1900
Group VIII
A.T.&S.F.
1905
1908

PLATE I.

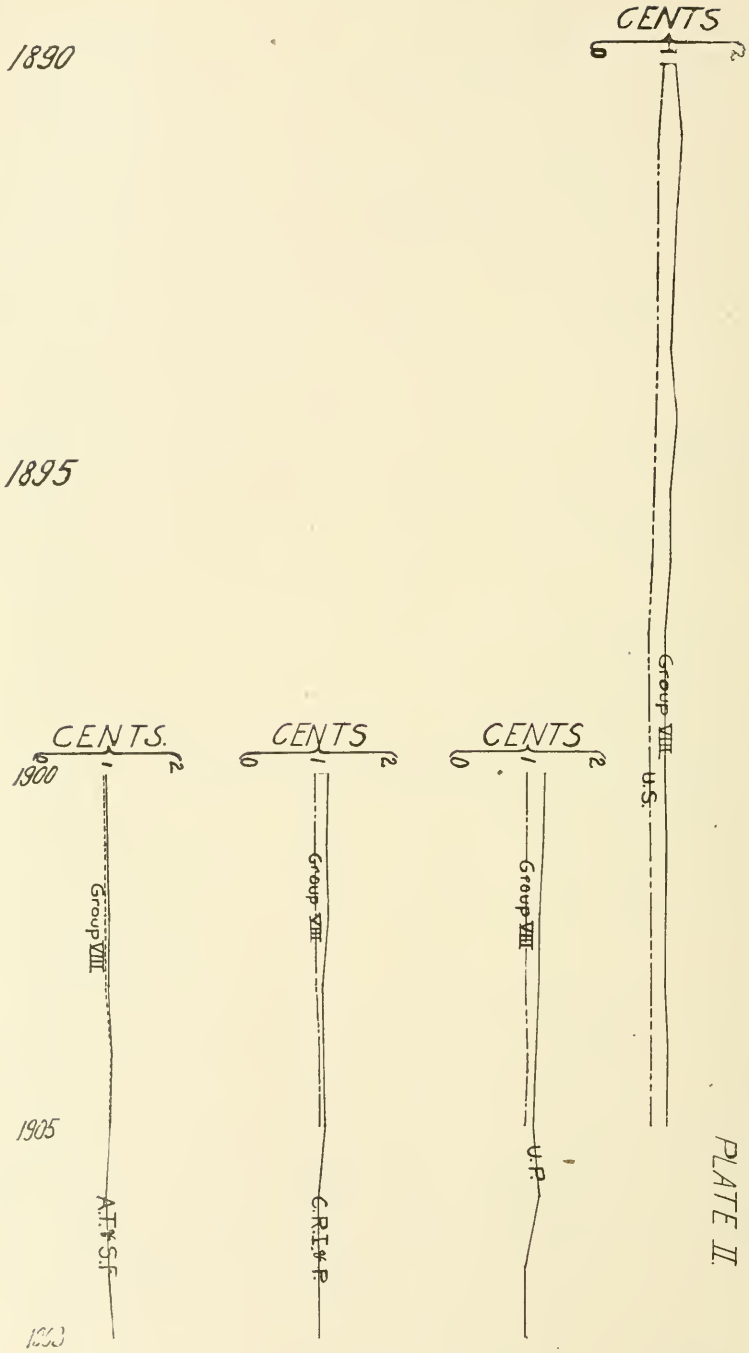


PLATE II.

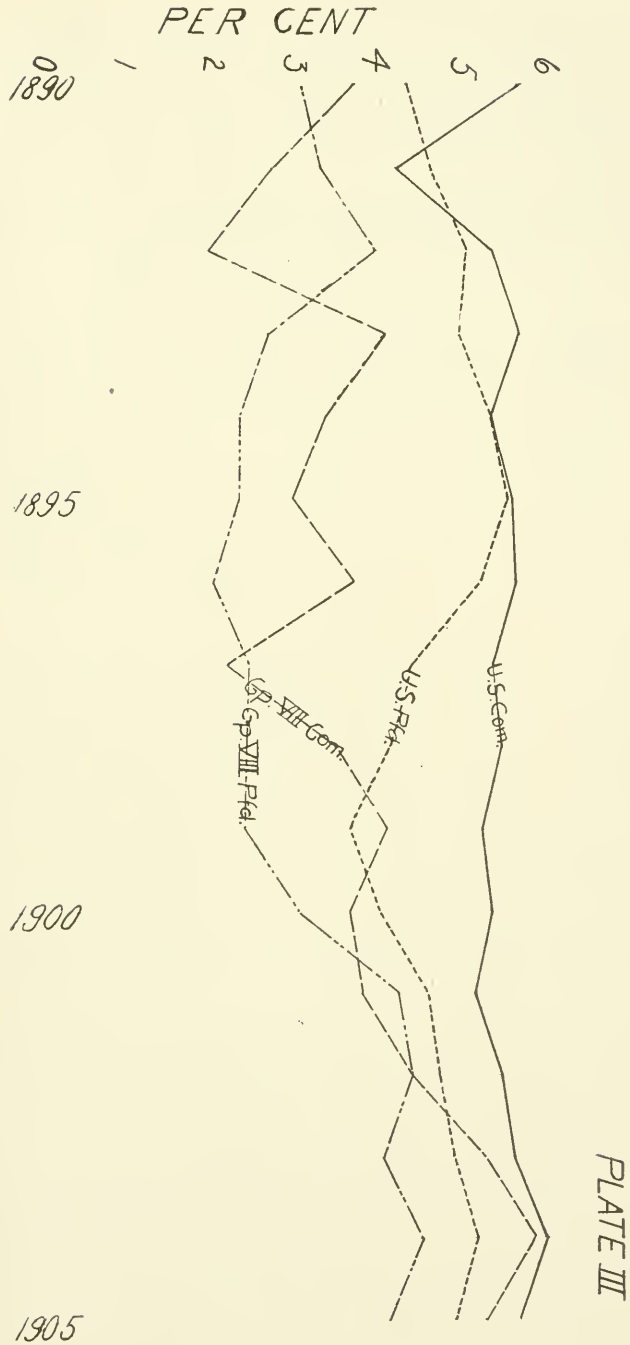

PER CENT
0
1
2
3
4
5
6
1890
1895
1900
1905
U.S. Com.
U.S. Pfd.
Gp VIII Com.
Gp VIII Pfd.

PLATE III

The speaker knows of one railroad being built that is bonded for a certain amount per mile, and when a man buys a $1000 bond he also receives $400 in common and $400 in preferred stock, which means that four-ninths, or almost one-half, of the entire capital stock is water.

The ninteenth annual report of the Board of Railroad Commissioners of Kansas gives the entire capital (which is the stock plus all outstanding indebtedness) per mile for the Santa Fe as $51,474, Rock Island, $44,196, and the Union Pacific, $133,535. From these figures one is easily persuaded that all railroad stocks are watered. At this point the question naturally arises, Shall the capital stock of railways and the dividends thereon be limited? If so, to what amount, and what shall become of all earnings in excess of a specified amount?

The speaker can only give his views on this subject, but he believes that they should be limited to an amount such that the money received from the sale of stock and bonds will just be sufficient to build and equip the line. Also, that the minimum price at which the stock and bonds are to be sold should be controlled by the government.

In order to accomplish these things in the simplest manner, I would suggest that all railroads be placed in charge of the federal government, and directly under the Interstate Commerce Commission, and that all state railroad commissions be abolished. Then, before any company could build a new line, or make any improvements on an old line extensive enough to require a bond issue, it should be required to submit to the Interstate Commerce Commission an estimate of the cost of such work. If after a thorough examination by the Commission's engineer this estimate be found correct, then let the company be authorized to issue stock and bonds, or bonds, for a sufficient amount to cover the cost of the work.

If these things were regulated as suggested, so that a prospective bond buyer would know that every dollar he invested in a bond would be used in the construction of the road, he would be much more willing to invest in railway securities.

The Interstate Commerce Commission should be given authority to reduce the capital stock and bond issues to an amount that would cover the actual amount of money invested, or the present physical value, if that be more than the original cost.

This may seem severe, but it is no worse than for the bondholders

to foreclose their mortgage and buy the property at sheriff's sale at a nominal price, and then reorganize the company.

Then the dividends should be limited to three or four per cent. and the surplus revenue used to better the physical condition of the road in order to protect life and facilitate the handling of traffic.

In the year 1905, as a direct result of the movement of trains, locomotives or cars, 533 passengers were killed and 10,245 injured, 341 of whom were killed and 6053 injured in collisions and derailments.

In order to reduce the number of collisions, some of the railways have adopted the block-signal system. This is operated in two ways; the one under what is known as the manual, and the other as the automatic. The manual depends upon telegraph operators for its successful operation. It was under this system, which is in use on the Southern railway, that Mr. Samuel Spencer, the president, lost his life in a rear-end collision on November 29, 1906. Upon investigation it was discovered that an operator had admitted the second train to the block before the president's train had passed out. It also developed that it was a common practice on the eastern roads to run two trains in a block at the same time. The officials claimed that it was necessary to do this in order to handle the traffic.

The automatic system is operated by dividing the track into sections called "blocks." The rails in a block are joined by wires reaching around the splices so as to give a continuous conductor for its full length. The rails at the junction of the two blocks are insulated. Then by an ingenious arrangement of batteries, relays, motors, etc., the semaphore boards are controlled so that when there is no train in the block the current flows through the rails and holds the semaphore at "safety," but as soon as a train enters the block it short-circuits the current by giving a connection between the two rails through the wheels and axles, and the semaphore then goes up to the danger position by the force of gravity. However, there is nothing in this to prevent a second train from passing on into the block excepting orders, which are given to the engineer by the dispatcher.

There is no reason why the automatic system should not be operated in such a way that it would bring the second train to a full stop in case it attempted to enter the block before the semaphore dropped to the safety position. This could be easily accomplished by having a lever which would set the brakes, rise up out of the ground high enough to strike an arm extending from the side of the locomotive or car, and would bring the train to a stand-

still independent of the engineer. Whenever the traffic becomes so great that it cannot be handled without running more than one train in a block it is time to add more tracks.

Many of the derailments are caused by poor track, and could be prevented by proper drainage and ballast.

Very few of the roads have rolling-stock enough to handle the traffic during harvest-time. It is not uncommon for a man to receive a car-load of freight from two to three months after he receives the bill of lading. At times this causes considerable financial loss to the consignee.

In winter the train resistance is much more than it is in the summer, and ordinarily it is unusual for a passenger-train to be on time. I remember one winter night of boarding a train for Kansas City, at Springfield, Mo., and waiting for one hour for two locomotives to start the train. When we did start one locomotive pulled the train into Kansas City, arriving there five hours late. While waiting in the depot for my next train I met a friend who was returning from New York, and he was only four days behind time.

Many of the coaches, and sometimes even the waiting-rooms, are so dirty that they are not fit for a lady to enter.

It seems to the speaker that the rates are as low as the people should ask, but that they should think more of the safety of human life, of convenience to the traveling public, and of the expeditious handling of freight, than of a few cents saved in passenger and freight rates.

The following recommendations are suggested: Abolish all state railroad commissions. Place all railways under the Interstate Commerce Commission, with full authority, first, to limit the capital stock and dividends, and, second, to compel the railways to use all net earnings in excess of dividends in the installation of safety appliances; improve the road-bed; increase the rolling-stock; run additional trains, so as to run them on time; furnish commodious and clean waiting-rooms; permit no railway grade or crossing without an interlocking plant, etc. After a number of years, when all these things have been accomplished, then use the excess in paying off the bonded indebtedness.

ON THE CARE OF MAMMAL SKINS KEPT FOR MUSEUM PURPOSES.

By L. L. Dyche, University of Kansas, Lawrence.

THIS paper is in part an answer to, or at least was suggested by, numerous inquiries, by letter and otherwise, concerning the proper methods of caring for the larger mammal skins for museum purposes. The writer has been handling mammal skins in one form or another since he was a boy, and has been trying to tan, cure and preserve them for more than forty years.

When a boy I tanned skins by rubbing salt and alum on them and then folding and rolling them up so that the two halves of the fleshy part of the skin would stick together. After a week or ten days the skins were opened up; the flesh and fat being scraped off, they were rubbed until they were soft and dry. It took more or less hard work but the results were not bad. It so happens that I still have an opossum skin that was tanned nearly forty years ago. It was made into a little rug and has seen considerable service on the backs of chairs, and yet it is in better condition now than some skins that I have handled in more recent years by some newer and supposedly better methods. A squirrel skin that was tanned about the same time is in much better shape than the opossum. The squirrel skin did not have any grease in it. The opossum skin evidently had some grease left in it, though it did not show at the time it was tanned. The subject of grease in skins will be considered later on in this paper.

I want to say, before going any farther, that it is very important that a skin should reach the museum in good condition. It seldom happens that a skin is in good shape that has been taken from the body of an animal that has died from some kind of disease. The hair on such a specimen will usually slip in places while the skin is being dressed and tanned. An animal that has begun to decompose—even though slightly—before the skin is removed, usually furnishes a doubtful skin.

The good skins that come into a museum are those that have been taken from animals that have been shot or trapped and cared for by experienced collectors; and I might say farther that these are about the only first-class skins that ever do reach a museum. Many skins are sent in by inexperienced persons who are more or less interested in specimens for museum purposes. Such skins reach the museum in every conceivable condition. As a rule they

are covered with more or less blood and dirt, with feet and head only partially skinned and spoiling.

Whole animals are not unfrequently sent to the museum. In cool weather this sometimes proves more successful in the hands of the inexperienced than sending the skins in a mutilated condition without measurements or any bones to take measurements from.

The skins for museum purposes should be cured as soon as they are removed from the bodies of the animals. In the field the writer usually cures skins by rubbing plenty of salt on them.

The feet of all animals with toes, such as bears, beavers and foxes, should be skinned down to the very bases of the toe-nails, and animals with hoofs, like the ox and the deer, should not only have their feet skinned down to the very hoofs, but the hoofs should be skinned loose from the toe bones that fit in them, and then, to make sure that everything is right, remove the toe bones from the feet as soon as the skins reach the museum. The ears should be skinned to their very tips on the back side of the cartilage and turned inside out. Leave the cartilage adhering to the inside ear skin to protect it until the skin is ready to be mounted. Then it should be skinned out. The mouth and nose should be carefully skinned, saving one-half inch or more of the skin of the inside lips; all fat and meat should be removed from the lips and nose without cutting or injuring the skin.

The writer has cured skins in different climates by the use of salt alone. It should be rubbed onto every part of the skin, particularly the edges, around the mouth, ears and tail, until the skin is saturated with salt brine. Skins should be dried and folded so far as possible in the shade. While salt alone will do to cure skins with temporarily, yet when I have it at hand I prefer to mix a little alum with it, particularly in warm climates. The use of alum tans and hardens the skin a little and makes it hold its hair better. Some collectors use a little arsenic with the salt and alum while collecting in the field. It does no harm, and is good to keep flies away from skins in warm weather. The writer seldom uses arsenic except on the skins of the smaller mammals. To immerse the skin of a large mammal in a bath of salt and alum brine for two or three days gives the most satisfactory results. While collecting in the field a hole made in the ground the size and shape of an ordinary bread-pan will do. Spread the skin over this hole. Press a part of the body skin, flesh side up, down into the basin. Mix the brine in it and fold the head and feet of the skin into this basin. Move the head and feet around in the basin once or twice a day. Most

of the skins that I have collected in the field were cured in such an improvised tan-vat with good results.

SKINS IN THE MUSEUM.

At the University we look over skins as soon as they reach the laboratory, wash those that are dirty, and place them in tan-liquor for immediate safe-keeping. After a few days they are examined and moved about in the tan-vats. As soon as we are ready to work upon the skins they are hung on poles, a few at a time, over the tan vats and allowed to drain until the tan-liquor ceases to drip from them. Then they are taken to the laboratory, where they are redressed. To dress the skins they are spread over half-round timbers, or tanners' fleshing beams, and shaved and scratched with various kinds of knives and scrapers, the hack-saw being one of the useful tools used. Thick skins, like those of the walrus or the necks of such animals as the elk, moose or buffalo, are shaved until they are thin and of an even thickness. All bones are removed from the feet of the skins except the bones that fit in the claws of such animals as the fox, beaver or bear. I have learned from experience that it is dangerous to leave even a small toe bone in any kind of a skin, especially of the larger mammals. In time, if the skin has been dried, grease may come out of the bone and stain or rot the skin. If the skins are kept green in tan-liquor this may not occur, at least for several years.

TAN-LIQUOR.

Museum men and taxidermists are not agreed upon what constitutes the best tan-liquor. Some advise using nothing but salt brine. I have tried salt brine for ten years, but not with the best success. It sometimes allows skins to get "slippery," so to speak. Some use salt brine with sulfuric acid in it—even as much acid as an ounce to a gallon of brine. My experience has gone to show that this is too much acid for museum skins. It seems to destroy the fiber of the skins, particularly if the skins are left in it very long. Skins kept for one year in such a tan-liquor were very tender. A little acid—say one ounce to ten gallons of salt brine—enough to keep it sweet, so that it would not get slippery, might do; but I prefer to use a little alum in the tan-liquor and leave the acid out altogether, especially where skins are to remain green in tan-liquor for several years. Where skins are to be tanned for rugs, they may be placed in a salt and alum tan-liquor that has from one-half to one ounce of sulfuric acid in it. However, skins should not be left in such a solution for more than from one to three weeks, depending upon kind and thickness of skins.

My old standby for a tan-liquor, which I have used at the University for the past thirty years, has been made of salt and alum. Five quarts of salt and one quart of alum to five gallons of water make a tan-liquor that has kept individual skins in good shape for over twenty years. After making a barrel or tank of this liquor, it is usually tested with a hydrometer for a reading of about 15 on the index scale, which gives about a 15-per-cent. solution.

This is about the strength we use for the permanent keeping of skins. However, a saturated solution will not harm a skin if it is not left in it too long. Sometimes fresh skins are placed in a very strong solution, half salt and half alum, particularly if the skins show some signs of decay. If skins are left for a year or more in strong brine, the epidermis about the hoofs and claws is more or less damaged.

Last year we mounted some skins that had been in this standard tan-liquor for twelve years. They were in good shape and worked well, but, of course, were not so elastic as fresh skins. We are now mounting some that have been in tan-liquor and some that have been kept dry for over twenty years. These skins have some defects which will be explained now in this paper, under the heading of "Grease."

GREASE.

The one thing that has caused more trouble, and which, I think I am safe in saying, has destroyed more museum skins than all other agencies combined, is grease. If there is grease in a skin, sooner or later it will go to the bad. Some skins, like those of the deer or antelope, have very little grease in them. Others, like those of the bear, skunk, wolf, lynx and seal, are full of grease, and it is with great difficulty that it can be removed.

Over twenty years ago I packed away for experiment in a dry condition some antelope, deer and sheep skins that had been thoroughly dressed and cleaned according to the best methods then known for doing such work. The main body parts of these skins are in very good condition.

The skins were folded in rectangular packages with head, feet and hair side of skins on the inside of the bundles. In a number of cases where the toe bones came in contact with the fleshy sides of the skins there are greasy and rotten places, caused by the grease that exuded from the bones. The skin around the feet that contained these bones is more or less injured The noses on some of the skins that did not have all the grease worked out of them are tender and not much good.

I have finally come to the conclusion, after many years of pains-

taking care and labor in trying to take good care of museum skins, that it does not make much difference what is done to a skin, it will not keep—even for a short time—if dried, unless the grease is all worked out of it; and to get all of the grease out of fat skins is quite a serious proposition. No sure cure method can be given. In practice at the University Museum about everything we ever heard of other people doing, or could think of ourselves, has been tried.

As soon as skins reach our laboratory we begin to figure on how to get the grease out of them. After as much of the fat and grease has been removed as possible by the use of knives and scrapers, if the skin is very greasy it is washed with warm soapsuds made from good laundry soap and soapine. Sal soda is sometimes used. After a skin has been washed by using sal soda it ought to be rinsed pretty well, as sal soda seems to bleach the hair of some animals if allowed to dry in it. After this washing the skins should soon be returned to the tan-liquor bath to prevent the hair from slipping. In two or three days the skins may again be taken from the tan-liquor and hung upon poles, hair side out, to drip.

When the hair begins to dry on the outside and is still wet next to the roots, the skin is ready to be placed in a benzine bath. From one to twenty gallons may be used on a single skin, depending of course upon its size. Skins are usually left in benzine from one to twelve hours. A fat bear skin will stand twelve hours' soaking without injury if the weather is cool. If weather or room is warm, half that time would be sufficient. Leaving it in too long might cause the hair to slip.

After this bath the skin should be removed to a platform that will allow the benzine to drain back into the jar or tank.* The skin should now be squeezed and pressed so as to remove as much of the benzine as possible. Then the skin, while the hair is still wet with the benzine, should be immediately dried in corn-meal, plaster or sawdust. If the skins are small, as those of opossums or civet cats, they may be dried in a tray of corn-meal or plaster by covering the skins with the meal or plaster and rubbing the material into the hair and shaking it out, repeating the operation many times, until the skins are dry and the hair clean and fluffy. In my laboratory at the University there is a large tanner's wheel, seven feet in diameter and two feet wide. A bushel of meal or plaster is placed in the wheel with a number of skins. The door is tightly closed with bolts and the wheel started in slow motion and allowed

* There should be no fire, gas-jet burning, or match lit anywhere near where these benzine skins are being worked.

to run for hours. This is a very satisfactory method of cleaning and drying skins.

Plaster of Paris is a good cleaner and drier for a skin after it has been in benzine, but it is hard to work plaster out of the hair, especially of a dark-colored animal. To get plaster, corn-meal or sawdust out of a large skin, it may be hung upon a pole in the sunshine and wind and beaten thoroughly with riding-whips. A piece of small rubber tubing on a handle sometimes answers the purpose. This is about the only way it can be done successfully unless one has compressed air, which can be used with the very best effect. If one benzine treatment does not do the business, a second or even a third one may be given.

After scraping and washing some fat polar bear skins until the entire museum force had worn itself out, we spread them on the floor, flesh side up, between two doors where we were accustomed to do a good deal of tramping, and covered them with three or four inches of sawdust. We walked over them more or less for a month, and the treatment aided very much in removing the grease from the skins. At that time we did not make such general use of benzine for cleaning fat skins as we do now, and did not have a tanner's wheel or compressed air in the taxidermic laboratories.

If skins of the larger mammals are to be mounted, my experience has been that they had better be kept green and soft in tan-liquor and never allowed to dry; and I might say farther, that the sooner they are mounted after they have been cleaned and tanned the better they behave themselves. When skins have been kept dry for a number of years they seem to lose their life, so to speak. They have very little elasticity, and it is hard to make them assume their original shape on a well-formed statue. Skins that have grease in them can be kept much better green and soft in tan-liquor than in a dried condition. If such skins are taken out of the tan-liquor and dried the grease in them soon burns them and they get rotten. Skins that have been thoroughly cleaned and freed from grease can be dried and put away for safe-keeping. They should be kept in moth proof cases and in as cool a place as possible. The flesh side of the skin may be poisoned with arsenic so that insects will not eat it, but this does not always save the hair. As a rule "moths" will not bother the hair of a skin that has been soaked in tan-liquor and allowed to dry with a light deposit of the salt and alum on the hair. We have kept skins over twenty years in the University museum in this condition that were not protected by moth-proof cases, and they have not been disturbed by any skin-eating insects.

NOTES ON THE PHOTOGRAPHY OF WILD BIRDS.

By J. B. PARKER, State Agricultural College, Manhattan.

THE task of securing photographs of our birds in their wild state has for the student of bird life a peculiar fascination that enables him to persevere in his efforts in spite of the many trials and difficulties with which he is continually beset. No work with which I have had any acquaintance requires more patience, perseverance and fortitude than that of bird photography. It is a pursuit that calls for and usually arouses great enthusiasm, but I have learned by experience that it requires more than a superabundance of enthusiasm to enable one to secure good photographs of the birds, and in this short article I shall try to set forth some of the things my experience has taught me.

First in order comes the matter of equipment. I began with an ordinary 4 x 5 outfit, such as may be secured from any dealer in cameras. I soon found out that the rectilinear lenses, with a maximum speed of *f* 8, supplied with such cameras, are too slow. Although most of my work was done with a lens of this kind, I found that, when working with the living, active birds, satisfactory results could be obtained only in bright sunlight between the hours of eight A. M. and four P. M., since it was impossible to use an exposure of greater length than one one-hundredth of a second. On cloudy or hazy days nothing in this line could be done, and even on bright days, if a cloud obscured the sun at the critical moment, I was forced to sit idle and look on while some of my best opportunities passed by. To my mind, therefore, a lens of high speed, one with a maximum speed of *f* 6.5 or *f* 6, is a necessity. If the lens is to be used only for this work, a rectilinear of the requisite speed will prove as serviceable as any, but if one lens is to be used for all kinds of scientific work an anastigmatic lens is to be preferred.

With a fast-working lens we should have a fast-working shutter. This requirement is best met by the focal-plane shutter, with which, however, I have had no experience. Next to this type stand the between-lens shutters of the diaphragm type. Good work can be done, however, with the kind of shutter commonly furnished with cameras, as my photographs show, yet when the camera is set close to the nest it is next to impossible to secure a good photograph if the bird is moving at the instant of exposure. This deficiency in

the movement of the cheaper grade of between-lens shutters I have found both discouraging and expensive.

The size of the plate to be used is a matter for the operator to determine for himself. I consider a 4 x 5 the most satisfactory size, but with this plate I should use a lens listed to cover a larger plate; that is, I should use a lens having a focal length of 8 or 8½ inches instead of one of 6 or 6½ inches, the size usually supplied with 4 x 5 cameras. The advantage in this combination lies in this: (1) Photographs with images of the desired size can be secured with a lens of 8-inch focal length at a greater distance from the object than with one of 6-inch focal length, and thus the photographer may work at a greater distance from the birds; (2) this increased distance from the object made possible by the use of the larger lens increases the volume of light admitted to the 4 x 5 plate during the brief exposure rendered imperative by the nature of the subject; and (3) better definition is secured, since only the center of the field of the lens is utilized.

Another important consideration is the plate to be used. The fastest plate made is none too fast for this work. It is not so important that the photographer choose this brand of plates or that brand, as it is that he choose a good brand and then stick to it. It required an entire season to convince me of this necessity, but since the first year I have always used one brand of plates; not because I believe it is the best plate made, but because I have learned how to use this plate, have made myself familiar with its possibilities, and know just what I can do with it under given conditions of light. The photographer must know when he can and when he cannot secure a good negative with a given exposure, and this knowledge the amateur is not likely to acquire by using first one brand of plates and then another. Select a fast plate of known quality and stick to it; do not add to the difficulties by using plates with whose possibilities you are unfamiliar.

Selecting an equipment is a small matter—the real work begins when we set out to secure the photographs. The birds refuse to pose for us and as a rule build their nests in situations that seem to be selected with the express purpose of baffling the photographer. To secure photographs of nests and nesting sites, however, is not a task of great difficulty, since with these we may use time exposures. But when it comes to securing photographs of the birds themselves, especially when they are busy feeding and caring for their young in the nest, we have a task of quite another character.

In my efforts to obtain photographs of this kind I have made use of three different methods. In my first attempts I tried to use my camera as a hand camera, but the results were so discouraging that I consider my efforts worse than wasted. With a camera of the reflex type good work, I presume, can be done in this manner, but with the common type of camera the whole thing is mere chance and guesswork. A better plan is to place the camera in position, focus it upon some definite point and then, with one end of a long string attached to the shutter and all in readiness for an exposure, sit in concealment at the other end of the string and await your opportunity. Instead of a string some use a long rubber tube with bulb attached. In many cases where situations were favorable I found the use of the string a very satisfactory method. But it has two serious disadvantages: First, you are too far away from the nest to see what is going on and so have but little opportunity to study the home life of the birds, while at the same time you are never sure of what you are getting when you make an exposure, and, second, you disturb or alarm the birds whenever you approach the camera, as you must necessarily do, in order to prepare it for a subsequent exposure. When following this plan I frequently failed to get what I desired, because of the difficulty of releasing the shutter at exactly the right instant. If better may not be had this plan will do, but to Prof. F. H. Herrick, of Western Reserve University, belongs, I believe, the credit for having hit upon a plan that I consider the best yet devised.

This requires a tent in which the operator works concealed, and if the nest in its natural situation does not permit of the use of the tent, the nest is moved to a position where the tent can be used. In moving the nest we depend upon the attachment of the parent birds to their offspring to cause them to follow the nest, and in every case in which I found it necessary to move the nest the old birds followed it up promptly. The birds soon become accustomed to the tent and the new situation of the nest and go about their duties in their usual manner. In the list of birds whose nests I have moved are included the chipping sparrow, wood pewee, Acadian flycatcher, robin, summer warbler, redstart, cedar waxwing, kingbird and Cooper's hawk. The tent I used was made of green denim supported on a light framework consisting of a ridge-pole four feet six inches long, two upright pieces six feet six inches long, each shod with iron at the lower end, and crossed two feet from the upper end by a cross-bar four feet long which was attached at its middle point to the upright by a screw. This per-

mitted the cross-bar to swing around parallel to the upright when the tent was folded. The tent proper, all in one piece with a series of openings in a vertical row a little to the left side of the middle of the front end, had four stout cords attached to it at the points where the ends of the cross-bars supported it. By means of these and four stout pegs the tent was securely guyed down to the ground. The four corners of the tent itself were fastened to the ground with long wire pins, and one of the rear corners was left open for ingress and egress. This worked well when pitched in the shade, but when in the open field in a July sun I found it necessary to cover the tent with a heavy woolen blanket to keep out the heat.

This plan has been denounced by some, who insist that the results obtained are unnatural—a misrepresentation of the facts in bird life. They maintain that the nest should never be moved from the place where it was constructed—that all photographs should represent natural conditions. Those who raise these objections do not hesitate, however, to remove leaves and twigs or push aside weeds and grass, or even to lop off branches, that they may obtain an unobstructed view of the nest in its "natural situation." Removal of the nest, with or without the nesting bough, is an interference with the natural conditions most certainly, but so also is a removal of twigs and branches or whatever else may obstruct a view of the nest. The whole thing is a question of degree of interference, and I have never found a nest yet with which I could work without interfering more or less with its natural surroundings. This much is true, however, that the home life of birds whose nest has been changed from its original position is as natural when they become accustomed to their new surroundings, which usually requires but a short time, as is the life of those birds whose nest has never been disturbed.

Whether the nest be moved or not it is necessary to have full sunlight upon it and the nestlings, and I have frequently found it necessary to devise an artificial shade of branches to protect the little birds from the withering heat of the sun. This shade was controlled by a string from within the tent and was pulled aside when the old birds came to the nest. It is never wise to meddle with a nest when the nestlings are quite young, either to expose the nest to the direct rays of the sun or to move it. The heat of the direct rays of a summer sun will soon prove fatal to very young birds, and the attachment of the parent birds may not be sufficiently strong at this stage to induce them to follow the nest. With half-fledged birds there is but little danger of the old birds abandoning

them for any cause, and, if well fed, the young at this age will hardly succumb to the heat of the sun though subjected to it for several hours.

The advantage in using a tent lies not alone in the fact that better photographs can be secured by this method than by any other. Here the student of bird life, working only a few feet from the nest, all unobserved by the birds, can see and study all that goes on at the nest as the birds go about their household duties, feeding and caring for their young. He who has not had the opportunity of thus living with the birds has a pleasure still awaiting him that is well worth the seeking.

No. 1. Bringing down young Cooper's hawks.

Of all the birds that frequent the forests of Ohio none is more wary or more distrustful of man than is Cooper's hawk. On the 10th of July, 1904, I found the nest of a pair of these birds placed some sixty feet up in the forks of a large white-oak tree. The nest contained young, and to secure photographs of the birds and nest in its natural situation was utterly impossible, so I determined to bring the nest and young birds down to a position where I could make use of my tent. Accordingly, some fifty feet distant from

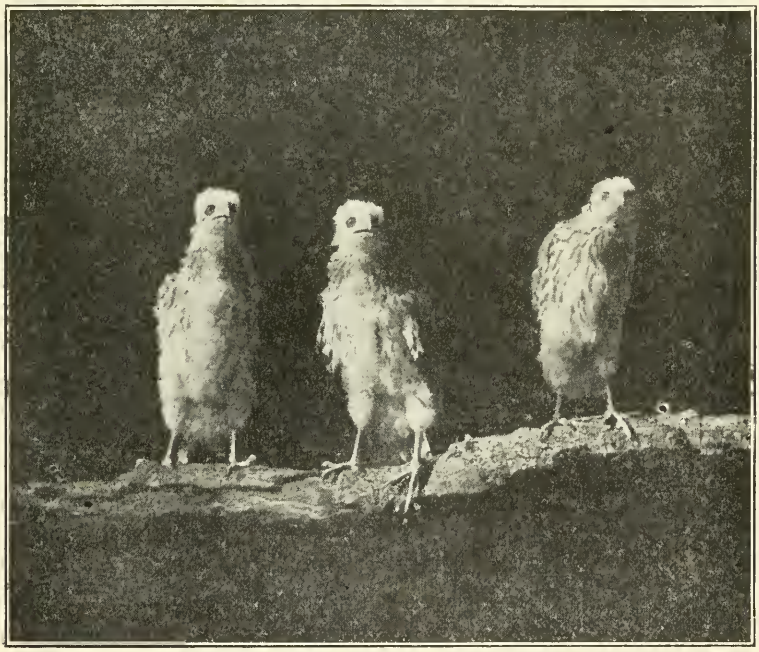
the nesting-tree, I set up a rest made from a dead dogwood tree on which to place the nest, and on July 16 pitched my tent. On July 17, in the afternoon, my nephew, Charles Hammond, climbed to the nest as shown in photograph No. 1, lowered the three little birds in a basket, and after securely tying up the nest with stout cord succeeded in lowering it also. The nest was placed in the support prepared for it and the little birds were put back into the nest as shown in No. 2. The nest and tent were then not disturbed

No. 2. Young hawks when nest was moved.

or visited until on the morning of the 19th, at which time I arrived at the nest and found everything in good condition. The old birds evidently had had no difficulty in finding their young and had not hesitated to feed and care for them in their new situation. The old birds were absent foraging when I arrived at the nest, so that I had ample time to get all in readiness for work long before the mother bird returned with food. When she did return she came without the least hesitation directly to the nest, bearing in her talons a meadow-lark from which she had previously stripped every vestige of feathers. Standing upon the edge of the nest, with her prey firmly held in one foot, she began at once to tear it to pieces with her beak, holding out to her little ones the smaller and more choice portions and devouring the coarser parts herself. The little hawks as they seized the food from the beak of their parent kept up a low happy musical chatter that to me seemed ill-suited to the gruesome meal they were making.

While this was going on I was busy inside the tent exposing plate after plate in an effort to profit by this long-sought opportu-

nity. I had only a common rectilinear lens to work with, and I knew that snap-shots here were out of the question, owing to the shadows of the trees and the dark background beyond the nest. I was forced to use short time exposures—a hazardous business when your subjects are birds busy at a feast. Of some two dozen exposures made in the course of the three days during which I persisted in my efforts, only two proved successful. Convinced of the inefficiency of my lens I made no further attempt to secure photographs of the old birds. A lens with a working speed of *f* 6 would have enabled me to do what I found impossible to do with my common rectilinear lens. I contented myself with securing a final photograph of the young hawks just the evening before they abandoned the nest.



Young hawks ready to leave their nest.

CANCER: THOUGHTS ON.

By J. M. McWharf, Ottawa.

CANCER and its treatment presents many suggestive questions. Our present knowledge of its pathology and treatment is indeed very meager.

While we consider the subject for a little time I ask that you drop preconceived opinions, and remove any and all prejudice, that we may study the real scientific or pathological history of cancer as we find it to-day. Preconceived opinions, unless founded upon facts, are of no real value.

Every disease save that of cancer is practically on the decrease, while cancer is on the increase, and to such an extent that it will before long give us a mortality annually greater than consumption and typhoid fever combined. In 1890 its death-rate in the United States was 18,536. In 1900, or ten years later, it had increased nearly one-third, or, in round numbers, to 29,475. We find that after having passed the age of forty-five one out of every twelve women and one out of every twenty-one men die from this most dreaded malady. In 1900 the city of New York gave a mortality of 724 men and 1336 women who perished from cancer. In 1900 there were 29,475 deaths from cancer in the United States, or a death-rate of 60 per 100,000 population. Upon the same basis England produced a death-rate of 82, Ireland 61, Prussia 61, Holland 91, and Norway 84. In one decade it has increased 30 per cent. Professor Parks, of Buffalo, N. Y., claims that if this ratio of deaths continues until 1909 we shall have a greater mortality from cancer than that given by consumption, smallpox and typhoid fever combined.

Some fifty years ago cancer produced 1 death in 129; to-day it is 1 in 25 or 30. This suggests sober, earnest thought at the hands of the medical profession. Evidently cancer has a separate and distinct individuality not yet brought into our field of vision.

The world's greatest pathologists have studied and investigated along this line for ages, but to-day the outlook presents nothing hopeful or flattering. The outcome of investigation and discussion has produced two classes in the medical profession—one that holds directly to the idea of heredity, while the other couples infection and contagion with heredity.

In this discussion it is not my desire to take a positive stand with

that class of scientists who claim that there is nothing in the question of heredity. It is my candid opinion that a very large per cent. of all cases are the result of contagion or infection. From a statistical standpoint we could cite a large number of cases which give no evidence whatever of heredity. I have not the time nor the desire to thus impose upon your good nature.

What is the source of the contagion? Twenty-one years ago Sir James Paget said: "I believe that microbe parasites, or substances produced by them, will some day be found in essential relation with cancer and cancerous diseases." Hundreds of years before this time cancer was looked upon and believed to be due to a crab which was eating up the tissues. Were not the people in fact reckoning far better than they knew? We believe it is due to an animal so exceedingly small that it can only be recognized by the aid of a good microscope. This animal belongs to one of the lowest forms of life, an Ameba. We sometimes call it the proteus animalcule. It is found in the mud, ponds and pools of stagnant water. Under the microscope it appears transparent and resembles in form jelly. It has an outer and inner substance. The octoplasm is very transparent; the endoplasm presents a grayish tinge, probably due to minute solid particles, and is termed granular. It is undigested particles of food which the ameba has eaten, combined with bubbles of water. By close observation we can see the expanding and contracting of the body in taking food. The ameba has what is termed pseudopodia, or false feet. When they come in contact with anything desired as food it throws out the feet beyond the object, literally engulfing it. Having secured the prey, a little water is thrown out of the surrounding protoplasm with the food. Doubtless upon examination we would find some secreted substance which acts upon the prey and converts it into the necessary condition for its use. If we expose the ameba to conditions unfavorable, such as a dry atmosphere, it will enclose itself in a cyst and become sphere shaped. In this condition it can be carried about like a particle of dust.

A test of some thirty cases of cancer was made, which resulted in the discovery of an ameba which did escape the notice of the old investigators. The granular bodies were noted and mentioned as far back as the use of the microscope in the investigation of cancer. They were looked upon as broken or degenerated tissue. They were found in the blood-vessels and tissues of the individual infected with cancer, and frequently quite remote from the seat of the disease.

The ameba may be in the blood circulation of many, and yet, if every cell in the body remains normal as to its resisting power, it will overcome any and all attacks of the cancri-ameba. But in the event of lowered vitality from injury, bruise, or any cause whatever, these cells at once become weakened in their ability to resist, hence cannot repel an attack of the enemy; in a word, the nucleus of the disease is established.

How do these cancri-ameba reach the weakened spot? By riding upon or following the blood current. When once established in an epithelial cell its strength is more vigorous. It will then have the power to attack and overcome cells which have a greater integrity. It is found that these spores, even before they have separated from the parent, send out pseudopodia that prey on the epithelial cells which they come in contact with. Nature is ever ready to meet these threatened attacks, and as soon as the cancri-ameba opens battle the neighboring cells take on increased activity, multiplying and becoming more gigantic. This accounts for the proliferation of cells in the vicinity of the malignant tumor. The active cells press on those of the cancer from without, while the cancri-ameba crowd from within, and we have as a result flattened cells.

The battle for existence doubtless produces that hardness characteristic of cancer. The harder the cancer the slower its growth. In the encephaloid variety nature makes but little objection, hence a more rapid termination.

It is a sad fact, yet nevertheless true, that the best fortifications of cells are finally penetrated and crumble before their antagonist. This opens up a field for the leucocytes. The hardened mass shows evidence of softening, then follows an ulcerative surface. Upon this surface, by the aid of the microscope, we are able to detect the dead and dying from both sides. Now the leucocytal vultures will consume them.

The results given above are not always true, for the cell life may be so active and effective that the cancri-ameba will be effectually imprisoned and die from inanition. Should this result be produced the hard tumor formed will be cared for by nature, diminishing in a degree, and finally remaining stationary. This could with propriety be called nature's cure of cancer. Now and then nature produces a like cure in phthisis pulmonalis by throwing a wall of calcareous material around a nest of tubercle bacilli, and they also perish from starvation.

In the formation of cancer, if connective tissue prevails we have what is termed hard cancer; if epithelial cells, we have soft cancer;

and between the two extremes there are many grades. It may be said that in this warfare the normal cells are going wrong. This cell growth, as I have stated, is usually rapid and soon produces pressure upon the nerve or nerves, which in time will excite pain. Soon after this stage is reached comes the breaking down of cell-tissue. This condition continues until the parts are destroyed or death from hemorrhage results. Not infrequently these cells break loose from their moorings and are carried with the blood current, the leucocytes being unable to resist or destroy them, when at last they settle down in a new field, there to grow and multiply, sending their branches in every direction. The lymphatic glands sooner or later show infection, then the vital organs—stomach, lungs and liver, until all adjacent tissue has been fully impregnated with the virus.

The frequency of cancer excludes the idea that all cases are hereditary; further, we do not hesitate to say that it has been demonstrated by incontrovertible facts that the disease is contagious and infectious: (1) We believe that cancer is not influenced by climate, rainfall or elevation; (2) the various articles of food when taken have no bearing; (3) neither malaria nor tuberculosis change the per cent. of death; (4) a greater susceptibility exists in certain races, especially the Teutonic and Scandinavian.

We must next consider the question of environment and habits of the people. Do they play an important part in the production of cancer?

People in the European countries, who consume the greatest amount of beer, produce the greater rate per cent. of deaths. Doctor Arnauldt found, upon one street in Normandy, seventeen houses which gave twenty-one cases of cancer. In his opinion they were the result of contagion and infection. The people of America furnish a very large mortality rate among cancer nurses.

We have a class who claim that the origin of cancer is a low state of cell activity. If a wound or blow is received by such individual it would be sufficient to produce cancer development, as the cells are too weak to heal; that with age comes a loss of vital forces and cell vitality. This condition may be assisted by sedentariness, overwork, mental anxiety, impure air, want of sleep and rest or a lack of outdoor exercise. The body must be kept in a healthy condition, good assimilation and metabolism, good full respiration and oxygenation, with the elimination of waste products.

We have touched upon the points suggested by the two rival schools; let us now consider the ideas that seem to prevail at the

present time as to the pathology and history of cancer. By laboratory experimentation it has been demonstrated that cancer may be endemic in animals. Desiring to ascertain facts along this line, Hanan, Burrell, Michales, Loeb and many others entered the field of investigation. The results of their experiments were of such a nature as to prove beyond a doubt that the disease was endemic in character, and infectious. Animals were kept in cages and their diet controlled, as this gave the observers a far better opportunity to perfect the observations as to the infectiousness of cancer, and the results were of greater significance.

Pick, of Germany, discovered the endemic occurrence of cancer of the thyroid in brook-trout hatcheries. Bennett reports the same condition, it having occurred in the Tarbole hatchery on the Gardasee. In the Tarbole hatchery there was a destruction of 3000 trout from cancer of the thyroid. Pick farther states that when the fish were infected the disease was confined to indivdual tanks or pools. If fish free from infection were placed in these pools or tanks they soon acquired the disease. Heredity could not be considered as a factor, but that the disease was endemic and that the water of these pools or tanks must have contained the agent which produced the disease.

In 1904 Loeb carried forward a series of experiments with rats, desiring to prove the endemic nature of cancer, and the results produced, to his mind, were conclusive, viz., that the disease was endemic. After the completion of his experiments, the cages were sterilized, except two, and again filled with healthy rats secured from another part of the country. In due time the rats that had been placed in the unsterilized cages showed positive evidence of cystic sarcoma of the thyroid. The sterilized cages showed no evidence whatever of unhealthy rats. These experiments were carried on some six or more times, producing the same result. Doctor Loeb demonstrated sections of the primary and inoculation tumors at various times before scientific societies, and the consensus of opinion by all pathologists present was that the samples were true spindle-celled sarcoma. We must therefore consider these tumors as malignant.

From a scientific standpoint we could produce for your consideration a very large number of cases that would prove beyond question the theory of communicability and endemic nature of cancer.

I am looking forward to the time when we can and will have overcome what seems at the present moment to be an unsurmountable

difficulty; that is, a perfect knowledge not only of what cancer is, but its therapy. In the advance of intellectual progress, in the sunset splendor of the nineteenth century, there will be brought forward a panacea for this most dreaded disease, cancer. For a long time cancer has been looked upon as absolutely incurable, therefore the physician feels justified in making an unfavorable prognosis. The prognosis is true in a large number of cases, but is not caution necessary? A diagnosis by competent men may not always prove true. Again, cases of undoubted cancer have been known to retrograde, or remain at a standstill for a long time, while others have been practically cured. We have a number of cases reported where from a microscopical standpoint a diagnosis was made and yet recovery took place.

Numerous cases have been reported by Virchow, Senger, Mohr, Alsburgh, Kroenlem, Bear, Lindner, Hahn, Osler and others, where recovery took place. At a medical society in London, Doctor Gould presented a patient who had apparently recovered, and yet, eight months prior to this time, seemed to be near death from recurrent mammary carcinoma, with glandular involvement and secondary deposits in the lungs. Doctor Beatson, at the British Medical Association, passed a photograph of a case of carcinoma in a woman who had been under his observation for six years. The evidence showed, per photograph, a removal of the breast by the surgeon's knife, but this was not the case. The entire mamma had disappeared, taking with it glandular enlargement of the axilla. The standing of the medical gentlemen referred to above it such that I cannot but accept their statement as true, and, if true, the carcinoma cells must have perished from poor nourishment or invasion of the fibroblast which compresses them. Believing this to be a fact, we are forced to admit spontaneous recovery.

Having discussed to some extent the vital point or cause of cancer, we now pass to the consideration of its treatment. I wish that it were possible in the light of scientific investigation to present you with a treatment that is tangible. The remedies that have been tested from a medical standpoint in number is legion, but their beneficial effects are of little or no real value. The early and free use of the surgeon's knife is of greater worth than all other remedies combined.

During the last few years the X-ray has been brought into use, and by some highly extolled, but upon investigation the experience of those more careful in their deductions does not warrant such a conclusion. Finsen light, with the X-ray, and radium, may be of

value in superficial cancer from their destructive action, but I do not see any advantage to be derived from their use in preference to the knife. In skin cancer they may be of use, but in the more deep-seated cancerous tumors the general opinion is that they are *nil*, and in many cases harmful, especially the X-ray. Science, in her effort to produce a cure, no doubt has caused many of the medical profession to be overzealous, and they have jumped at a conclusion as to the therapy of cancer.

Professor Doyn, of Paris, announced to the world that he had produced a serum that would immunize a patient with cancer. The French and English commission gave this serum a thorough investigation and the result proved that it was of no value. Coley, working along the same line, the germ theory, manufactured what is termed "Coley's Fluid," claiming that it was a specific. Further investigation, however, proved to the contrary. McElwain, in 1875, held that cancer was the result of high living. He believed that sugar was an active factor as a cancer producer, but to-day the profession makes the statement that there is a lack of sugar in the system, hence fill their patients with sugar.

Much more time and space could be expended in further citations and doubtless it would be of interest, but the results would be of little worth. The facts are, we might as well be honest and say, so far as the medical profession is concerned, we have no known remedy that could be termed a specific, and nothing equal nor superior to the early and free use of the surgeon's knife.

The objects of this paper are:

First.—To call your attention to the increased mortality each year from cancer.

Second.—To point you to the fact that failure has largely crowned our efforts to prevent the spread or cure the disease.

Third.—We have been taking into account the theory of heredity and placing too much stress upon it.

Fourth.—We have failed to recognize the fact that cancer is absolutely a local disease during the first stage.

Fifth.—That waiting to act is positively harmful, as it reduces the chances of life.

Sixth.—The ameba may remain in a dormant state for a long time if kept dry, and then under favorable conditions become active. Hence every room of a house occupied by a cancer case should be thoroughly disinfected before it is again occupied. The same restrictions must prevail as found to be necessary from any contagious disease.

Seventh.—Scar tissue or an ulcerated surface have less resisting power than the normal tissue, hence greater need for care.

Eighth.—Age also renders the individual less immune.

Ninth.—Operations performed after the disease has passed the local stage are of far less value and much more dangerous to the patient.

NOTES ON THE GILA MONSTER (*Heloderma suspectum*).

By Bernard B. Smyth, Topeka.

EXHIBITING a live Gila monster, Professor Smyth said, in part: "This creature which I hold in my hand" (with a firm grip back of the head) "is the northernmost species of the beaded lizards (*Heloderma*), this being an inhabitant of southern Arizona and northern Mexico, the other species (*H. horridum*) being a denizen of the hotter regions of Mexico. Whatever may be said of his Mexican brother, this one is a much maligned creature, on whose shoulders the mantle of the ancient basilisk of two to three thousand years ago has fallen, since the basilisk is shown to be an innocuous creature. The tales formerly told of the basilisk are now repeated concerning the Gila monster. If we are to believe all we hear of this reptile, its bite is sure death; its breath is fatal to cattle; its glance is certainly fatal; and when it bites it never lets go till the moon sets. While this fellow in his wild state and on the hot rocks and sands of his home is unquestionably to be avoided, in captivity and in a cold climate he is one of the most inoffensive and docile of creatures, the easiest to care for, and the cheapest liver imaginable." (Here Professor Dyche came forward and opened the reptile's mouth with his hands, showing that the creature had no fangs, and asserting that in captivity, in a cold climate, and in hibernation, like the rattlesnakes, the Gila monsters are not provided with poison.) "Its movements are sluggish; it requires no food to keep its blood warm as animals do; the surplus food that it obtains during the summer is converted into fat and stored up in the tail, which becomes a storage organ for winter sustenance. Its claws, as you see, are small and delicate, not intended for offensive movements; and it has to depend for safety upon its colors and its frightful reputation.

"You all know, of course (?), that in its native home the favorite food of the Gila monster is the Arizona tiger-beetle (*Amblychila picolominii*) from the mountains of Arizona; but you probably do not know (neither do I) that this insect is only obtainable at three o'clock in the morning of a rainy day when the moon is dark and the sun is in Gemini or Cancer; that it takes just twenty-five of the beetles to make a square meal for him; that the quotations on this insect have all along been thirty dollars apiece, until our dear lamented Doctor Snow, with his enterprising student

assistants, succeeded in collecting a few; and that the reptile can subsist and keep fat on about four square meals a year. In the absence of his favorite food while in captivity he manages to get along with ordinary hen-fruit. But he won't even look at cold-storage eggs; they have to be of the yellow-legged kind and smelling of the hen-coop. He, of course, much prefers the eggs of his ancient enemy, the desert tortoise (*Testudo agassizi*), or the rarer eggs and young of those tidbits of the desert, the Arizona quail and plumed partridge (*Callipepla squamata* and *Oreortyx pictus*); even the eggs of the golden pheasant (*Chrysolophus pictus*) would not be amiss; but he has to do without all these and be content with just common hen-eggs.

"This creature is of very ancient lineage; his family tree is much older than that of any of us. He, or, rather, his ancestors, have engraved their chirographic inscriptions on the plastic newly-molding shores of the old Carboniferous rivers and the yielding banks of the old red sandstone; and they in turn have conferred upon him their colors, which, as you see, have become permanent."

THE MEDULLARY RAY AS AN ELEMENT OF STRENGTH IN STRUCTURAL TIMBER.

By Frank E. Jones, Assistant Professor of Carpentry, University of Kansas.

IN the growth of the exogenous tree, the prime function of the medullary ray, as is well known, is the distribution of thee laborated foodstuffs to the active cells in the living zone, or sap-wood, as it is called.

As the successive annual layers are added and the protoplasm migrates outward, leaving the cells empty, these pith rays eventually harden into plates radiating outward in every direction from the heart of the stem to the bark, apparently forming part of the stiffening framework or mechanical support of the tree.

Whether or not the pith ray is really an element of strength is a much disputed question. Since most of the ruptures or radial cracks that occur in seasoning a section of an entire log are found to be either in the middle of a pith ray or immediately adjacent, many are led to believe that the pith ray is the weaker element.

There is a very apparent difference in the shrinkage of a tangential section or along the annual layers over that of the radial section, or in the direction of the medullary ray. This is accounted for in various ways by the different writers on the subject. The reason that seems to me to be the most logical is, in substance, as follows:

The shrinkage is directly due to the fact that as a section of wood gives up its moisture the walls of each individual cell become thinner, its diameter smaller, and as a consequence the piece as a whole shares in this diminution of size. Since the length of a fiber is a great many times its diameter, the effect of this contraction along the length of the fiber is inappreciable. The cells of the medullary rays have their length at right angles to the direction of the wood fibers, and this opposition prevents the latter from shrinking as much as they otherwise would, while between the rays or in the direction of the annual layers they are left free to contract as they will. With this theory in mind the first experiments were made.

Since hygroscopicity makes the expansion of dry wood-fibers by the absorption of moisture practically equal to the contraction of unseasoned wood by the evaporation of its moisture, this was made use of for the sake of making comparisons in the first experiments. Pieces of equally dry wood were cut to exactly the same dimensions,

with the longest dimension in each case running across the grain of the wood. In the one the medullary rays ran in direction of the length of the piece and in the other at right angles to it. Together these were immersed in warm water. and when saturated were taken out and measured. It was found that the total expansion of the piece with the rays perpendicular to its length was fully four times as great as in the one with the rays parallel. This test being made with white oak this difference is probably abnormally high. It is found that the ratio of difference prevailing in most of our woods is about three to two. In this case the medullary ray seems to be able to resist the natural forces resulting from the expansion or contraction. The question then arises, "Can the medullary ray in a like degree resist such external forces as may be brought to bear upon the timber?"

In order to answer this question a number of tests were made with various woods. The following are the principal tests made: Longitudinal shear, deflection or cross-bending, resistance to cleavage and compression or crushing across the grain.

In the longitudinal shear test one-half of the specimens were prepared with mortises running through the stick parallel to the pith rays, the other half with the mortises perpendicular to the rays. The average result of all the pieces showed a small per cent. of difference in favor of the ray.

For the cross-bending test a piece of wood was sawed out so that the rays would be exactly parallel to two faces and at right angles to the other two. This stick was then sawed in two and each half tested separately, the first with the ray parallel to the lines of force and the second at right angles. The results of this test showed that the piece with the rays presented edgewise to the load was able to support fifteen per cent. more for a given deflection, all other things being equal, than the piece with the flat side of the ray to the load.

In testing the resistance to cleavage, where the lines of force run parallel to the ray the resistance was approximately 1500 pounds to the square inch. With the opposite position the average was less than 500 pounds per square inch, and in each instance in the latter tests the failure occurred in one of the rays, showing that to at least one force the medullary ray yields before the fibro-vascular tissue does.

It was in the compression tests that the greatest difference was manifest. For this test the blocks were cut to exactly the same dimensions, the difference being that in one set the rays were vertical and in the other set horizontal. They were taken one at a time

and subjected to a steady crushing force until a definite rupture occurred. In the pieces tested with the rays parallel to the crushing force the average resistance per square inch was 3750, the failure occurring between the rays. With the other set, where the force was at right angles to the rays, the piece was held together by the rays until a pressure of 12,000 pounds per square inch was reached, or a little better than three times that of the former.

Structural timbers are being constantly tested in their ability to resist these forces, and if there is any virtue in placing a timber in a certain position in relation to the load it is to be subjected to it should be known.

It is not expected that these tests will be accepted as conclusive and final, but that the results of the experiments herein described give evidence that the medullary ray as an element of strength in structural timbers is well worthy of consideration and will invite further investigation.

DARWINISM AND EXPERIMENTATION IN BOTANY.

Synopsis of a Lecture before the Academy by Dr. D. T. MacDougal, Director of Laboratories, New York Botanical Garden.

A SURVEY of the present-day activities in any field of natural science would afford but meager data by the aid of which the actual trend of biological thought might be recognized, the most efficient methods of advance be determined, or research effort directed with certainty to the exploitation of the phenomena of living things offering the most immediate promise of widening human knowledge. Conceptions of this character may be gained only by the alignment in perspective of past achievements, or by noting landmarks along the devious way followed in the trial and error method by which practically all we know has been acquired.

It will be profitable, therefore, to focus attention upon the particular phase of development of biological science characterized by the establishment of the theory of descent and the full presentation of the inclusive generalizations of Darwin, especially with regard to natural selection, since the period in which this occurred was one in which a rapid and notable change in the prevailing attitude of the human mind toward natural phenomena took place.

Previous to the appearance of "The Origin of Species," and to the opening of limitless fields of research by efforts of Darwin, Julius von Sach's scholars were busily engaged in recording meager facts, in "interpreting the face of nature," the making of didactic comment taking the place of establishing relations between cause and effect, Dutrochet being the only physiologist whose efforts in this period are worthy of mention. Now, simple results of observations not in sequence, no matter whether concerned with the outline or minutiæ of leaf structure, flower detail, vascular anatomy, chromatin structure, chromosome involution, seasonal activity, or geographical distribution, do not give at first hand results of much appreciable value; whatever importance may accrue to data thus secured will be due to the manner in which they may be collocated. Properly carried out, this may reveal some forms of relativity, and forge the link between cause and effect in certain phases of biology. This may be rarely done effectively, however, and as long ago as recognized by Agassiz, it is peculiarly subject to the danger that comes from the investigator imposing his own ideas upon nature, of making colligations of the most unrelated facts, and of wandering

into speculations either unjustifiable or absurd. Inclusive, orderly and corrected results of pure observations in the hands of a master may indeed yield a rich harvest of well-grounded generalizations, as evinced by "The Origin of Species" and the derived theory of natural selection.

No greater tribute could be paid to Darwin than to recognize that the inexorable logic of his own mental processes quickly carried him into the ways of the experimentalists, and no sooner had his interest been fastened upon certain phenomena than he began to arrange cultures, comparative trials and experiments dealing with many important problems in physiology, and bearing upon almost every phase of heredity and descent, and he assiduously set about their execution while the greater number of his followers were still engaged in a conflict of words and a maze of phrase construction.

The interrupted task of bringing evolution within the scope of experimental science so fairly begun by Darwin has been most forcefully completed by DeVries. Like Darwin, his well-considered results obtained by twenty years of experimental cultures have been brought out with a new theory for the interpretation of certain phases of evolutionary development. Without appraisement of the importance of mutation as a factor in evolutionary procedure, it is to be said that the greater service performed by DeVries consisted in his demonstration that the method of trial and test is one by which major phenomena in heredity may be apprehended, their course, frequency and scope measured, and by operations of so simple a nature that it has enormously stimulated research upon the subjects concerned.

The general procedure by which we experiment with functional features of organisms, or their ontogenetic or morphogenetic development, is too well known to need detailed explication. It consists essentially in setting the organism into action and calibrating the products, whether these be movements, chemical structures, tissue formations, tropistic reactions, correlations, altered rhythms of reproductive departures. In all of these, developmental or evolutionary significance is of course taken into consideration.

Now if attention be wholly directed to genetics, especially in botany, it may be seen that not only have we perfected new methods of investigation but that we have used them to some effect in uncovering principles by which inheritance is governed. Allusion to some of the more important features may not be out of place.

The prerequisite in all work of this character consists in the operator or student having series of animals or plants of known lineage. Many species or forms occur in such manner in nature that no uncertainties as to ancestry or purity of strain exists, but in cases where closely related species inhabit the same area or are close neighbors, the possibilities of inter-crossing are to be taken into account. The problem awaiting the investigator may demand a pure strain, a hybrid mixture, or a collective species including two or more elementary species, races, or biotypes; but in any case, it is absolutely necessary that the nature of the immediate ancestry of the organism be definitely determined. The derivation and composition of a group having been ascertained, they and the successive generations arising from them must be grown under measurable conditions of soil and climate, and under known possibilities of hybridization, self-out- and cross-fertilization. In other words, the characters or qualities, the behavior and action of which are being tested, must be known as to their composition, purity or combination, exactly as the chemist must deal with substances of known constituency in his exacter work. This is the essence of the pedigree-culture.

It has become plainly evident that it is upon the idea of qualities or single characters that progress in research upon evolution must be based; no longer are we concerned with the origination of species, except as an easy generalization; species themselves are so diverse in their composition and aspects among plants, especially, that it might be said with justification that there are almost as many kinds of species as there are numbers of genera. Evolution concerns variations, accretions, diminutions, appearances or disappearances of qualities, and it is to these manifestations that our attention is now primarily directed, in the hope of advancing what has now become an exact science.

Having the unit character as a workable idea and with the power to manipulate examples of it in hybrids in which alternate inheritance may occur, it is obvious that widened opportunities are afforded for studies in the mechanism of heredity, especially in the fortunate instances in which the two components of a hybrid are characterized by the number, form size, or behavior of the chromosomes. Some light is also being thrown upon the problem of the physical basis of inheritance.

In a brief paraphrase of the principal ideas presented in this sketch, it is to be said that Darwinism, which has so profoundly affected human thought, and is without parallel so far as importance

of conclusions and force of suggestion are taken into account, was the climax of the purely observational method of advancing knowledge. It came at a time when biological thought was ripe for a change of attitude and method of dealing with natural phenomena. Its great author, together with other leaders in biology, passed almost wholly to experimentation in the discovery, demonstration and confirmation of the principles underlying the action of the constituency of the organic world. This method was used to the fullest extent, first in physiological inquiry, in the calibration of functional performances, and was later applied to ontogenetic development and the interpretation of form, so that now even the taxonomic and phyletic generalization lean upon its results for support. Genetics, descent and heredity escaped more slowly from the domination of illusive speculations and dogmatic philosophy, but now in these, as in practically all branches of human thought, we are no longer content with casual and hazardous arrangements of facts to fit preconceived theories, with unrestrained metaphysical interpretations of nature, but demand progression by experience and the foundation of generalizations concerning evolution upon known causes, appreciable mechanisms, and movements of ascertained direction.

Extensive fields of research lie without the domain of experimentation, yet the data gleaned from them must be put to the test of comparison with results analytically obtained. In a direct study of genetics we have at our command the pedigree culture; the conception of unit characters; some facts and a practicable theory as to the mechanism of heredity and the physical basis of inheritance; a better knowledge of the nature and causes of variability, due to the use of statistical methods, with a realization of the occurrence and importance of mutations; the power of inducing certain departures by the use of compounds or climatic factors; much evidence, chiefly of a paleontological character, as to definiteness of variations; a comprehension of the relations of environic factors to germ-plasm and soma, and some important results in selection obtained from breeding operations, together representing reasonable progress in the advancement of knowledge of a subject, established by Darwin, whose own work upon it remains its greatest contribution.

To Members of the Academy.

The present volume, delayed by pressure of work at the State Printing Plant, will be found quite equal to its predecessors as a contribution to science. By these published Transactions we are making returns to the state which so largely meets our expenses, and by our exchanges are building up a scientific library. This is a part of the great collection of books at the state-house which lacks now an administrative head, thorough organization and cataloguing. When these wants are met there will be no library in the state equal to it in size and value.

Our museum also is the nucleus of what may become of great economic importance to the commercial interests of the state, and our members should impress upon the legislature the needs of its enlargement. We need more members, and more unanimity and enthusiasm in scientific investigation. When we have quarters in the proposed new building we should make a new departure in the line of progress. Our Academy ought to be an important part of the educational machinery of the commonwealth, and we should have more frequent meetings and definite plans for coöperative work. The faculties of our colleges and others interested in science should meet here to discuss the questions in science constantly arising, and the Academy thus become a "clearing-house" and center of scientific activity for the state.

J. T. LOVEWELL,
Secretary Kansas Academy of Science.

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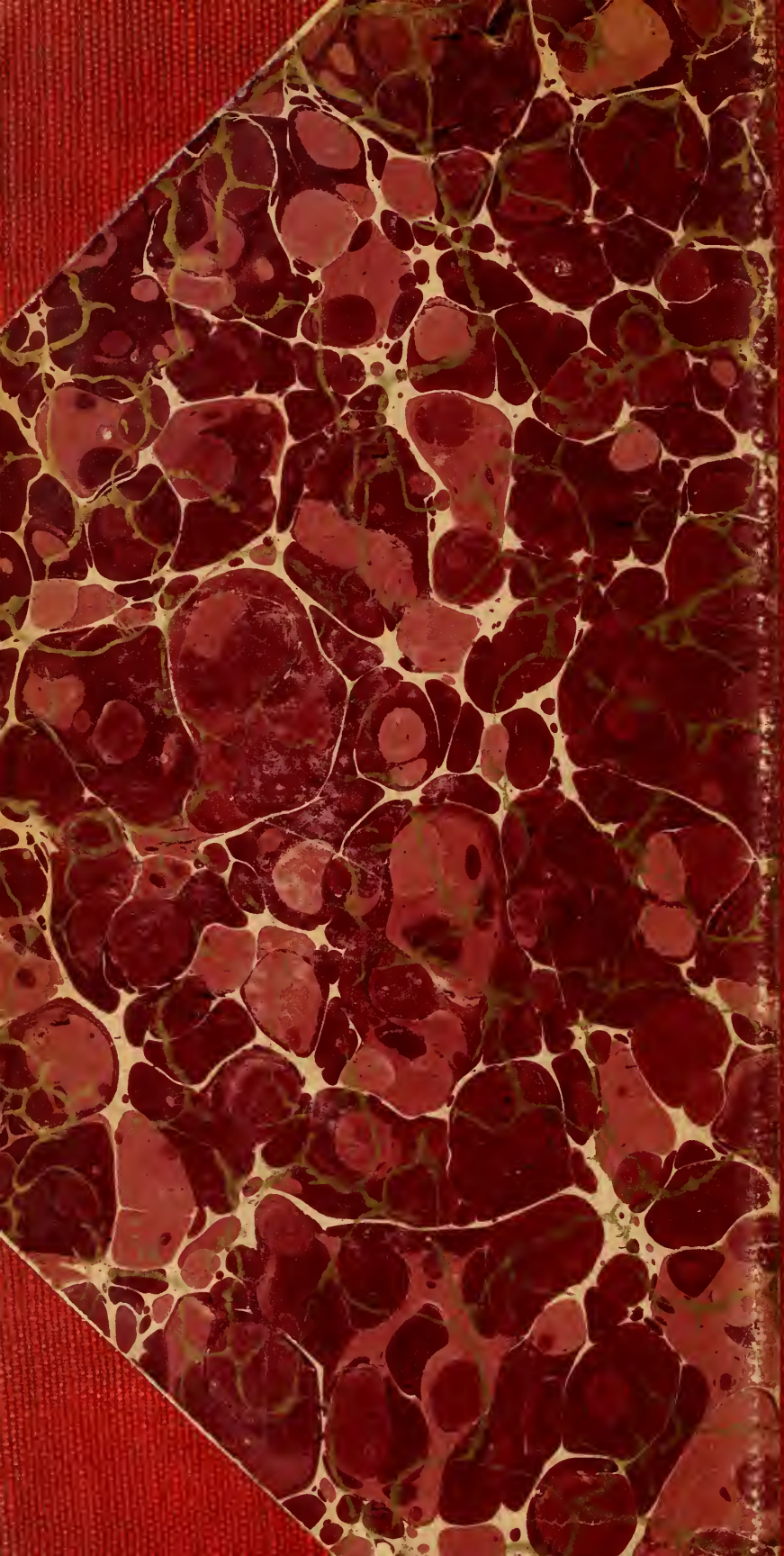
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